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THE COLLAPSE OF THE BIXBY HOTEL AT LONG BEACH, CAL., ON NOV. 9.

By H. Hawgood,* M. Inst. C. E.

The Bixby Hotel, at Long Beach, Cal., is a six-story reinforced concrete structure, in plan shaped like the letter H, built upon the beach with the basement floor a few feet above extreme high tide, and the first floor level with the top of the low bluff upon which the town of Long Beach stands. The collapse of Nov. 9 in which ten men were killed occurred in the cross-bar of the "H." The probable region of primary collapse is shown on the plan, Fig. A.

*Consulting Engineer, H. W. Hellman Building, Los Angeles, Cal.

The vertical members of the structure are columns reinforced with plain round rods, standing each on an independent foundation and extending in tiers, with a few exceptions, from basement to roof. The dimensions of the columns under the region of primary break are:

FOOTINGS:

Col. 20, 6 ft. 6 ins. square.

Cols. 19, 21, 22, 6 ft. square.

COLUMNS:

Basement to 1st floor 21 × 21 ins.; four ¼-in round steel rods; height top of floor to top of floor, 11 ft.

1st to 2d floor, round tapering, 26 ins. dia. to 22 ins.; six ¼-in. round steel rods. Height top of floor to top of floor, 19 ft.

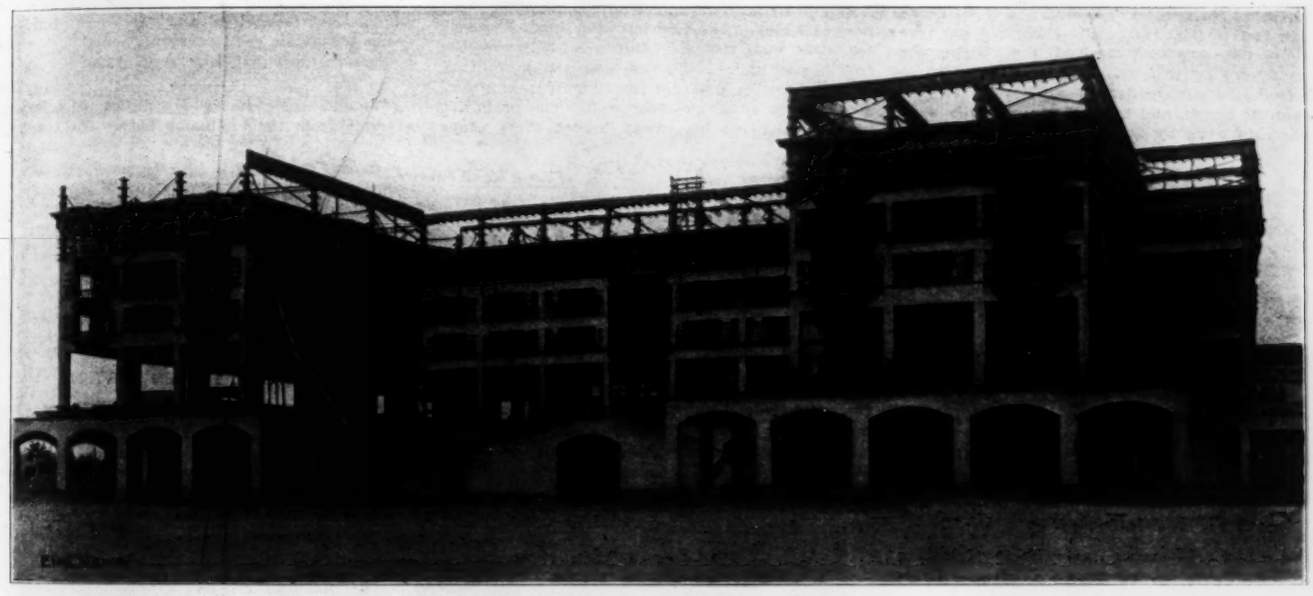


FIG. 1. VIEW OF HOTEL BIXBY, LONG BEACH, CAL., UNDER CONSTRUCTION OF REINFORCED CONCRETE.
(View Taken from Sea Front Oct. 25, 1906.)

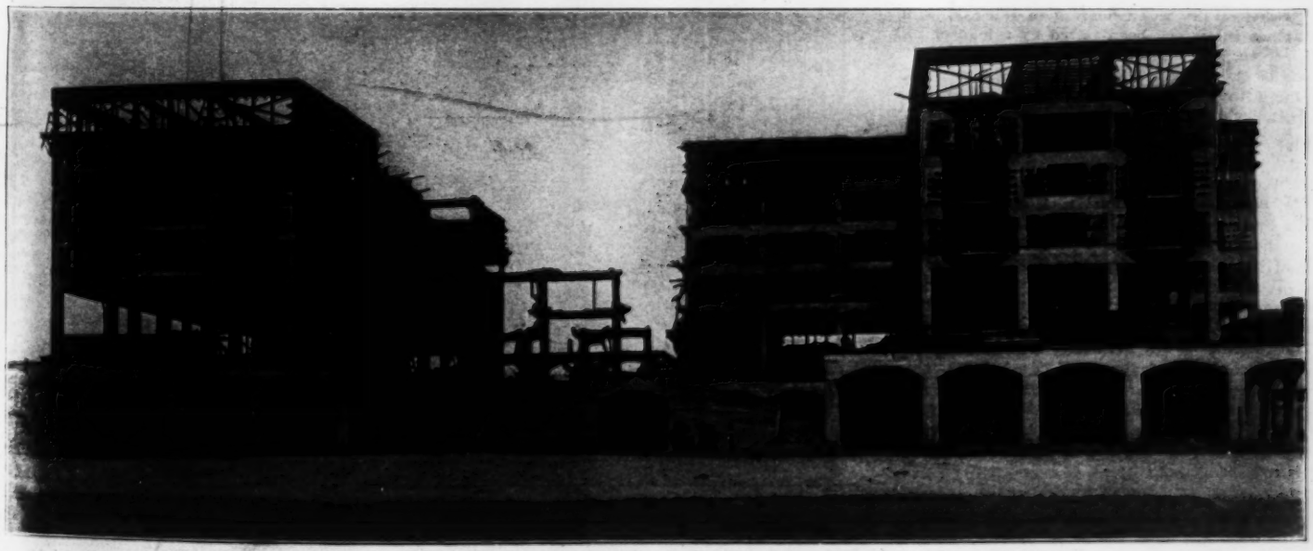


FIG. 2. VIEW OF HOTEL BIXBY AFTER COLLAPSE OF NOV. 9, 1906.

2d to 3d floor, cols. 19 and 21, 16 x 16 ins., four ½-in. round steel rods; cols. 20 and 22, 12 x 12 ins., four ½-in. round steel rods.
Height top to top of floors, all floors, 3d floor to roof, 9 ft. 6 ins.
3d to 4th floor, 10 x 10 ins., four ½-in. round steel rods.
4th to 5th floor, 8 x 8 ins., four ½-in. round steel rods.
5th to roof, 8 x 8 ins., four ½-in. round steel rods.

The beams and floors are of the Kahn system of reinforced concrete in combination with hollow tile and are built for the following floor loads:

1st floor, 150 lbs. per sq. ft. plus dead load.
All other floors, 60 lbs. per sq. ft. plus dead load.

The details of the beams and flooring in the region of primary break are shown on the accompanying tracing, Fig. C.

The concrete was proportioned: 1 cement, 2 sand, 3 broken rock; batch-mixed in a Ransome mixer and worked "sloppy." Boiling tests were made of the cement as received, a small percentage only failing to pass. The sand, brought by rail from the Arroyo Seco, near Los Angeles, is of granitic origin, and has been successfully used in concrete work by the railways and others for years. It contains, however, some soft pebbles of disintegrated granite. The rock up to the fourth floor, also brought by rail, is an igneous formation, hard, and breaking into angular fragments well adapted to concrete. The rock in the upper floor was obtained by breaking the larger stones screened from the Arroyo Seco gravel. The finished concrete as shown by the fractures of the wreckage can be classed as good.

The foundations, so far as they have been checked as to levels by the contractor, are unmoved.

A panel of the Kahn flooring in the east wing has since the wreck been tested by a load of 240 lbs. per sq. ft. Deflection, ⅜s of an inch. Clear span, 17 ft. 10 ins. The panel tested forms part of the fifth floor. Age of the concrete at time of test, 28 days.

Figs. 4 and 5 show that part of the third floor in the west wing stood under the impact and weight of the wreckage of the fourth and fifth floors, and suggests, the floor construction being alike, that without some contributory cause other than the fall of material from above, the floors should have stood everywhere else. Photograph Fig. 7 of the underside of a hanging portion of the fourth floor speaks well for the floor. This concrete was 18 days old when it fell.

The concrete in the fifth floor was 18 days old, and the concrete of the roof was being put in place when the collapse took place. The roof slab was 4 ins. thick, reinforced with Ellwood wire fabric and ½-in. round rods. The beams were 8x18 ins., spaced 8 ft. c. to c., reinforced with rods of Kahn pattern.

The foregoing would appear to eliminate from the direct cause of the accident, the materials, the foundations, and the floor system, leaving the responsibility either upon the finished permanent columns, or upon the temporary wooden posts supporting the roof construction, or upon both.

The coroner's jury took the view that the construction work was to blame, finding in their verdict that the collapse "was occasioned by prematurely removing part of the timbers supporting the fifth floor, and proceeding with construction of the roof before the cement beneath was properly cured."

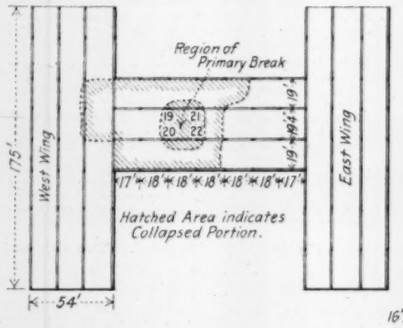


Fig. A. Outline Plan of Bixby Hotel.

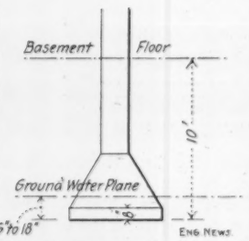


Fig. B. General Arrangement of Column Footings.

Fig. 8 shows the timbering between the fifth floor and roof in the part left standing. The center aisle was similarly timbered between the fourth and fifth floors, the side aisles on that floor being cleared except the column lagging and a few posts under the floor slab. The posts are 2x4 ins. and 4x4 ins., sway braced every other row, and wedged up directly from the floor without bearing plank. It is understood that the same methods of timbering were employed from the second floor up.

From the mass of evidence given at the inquest the following has been taken as the most significant:

A plumber working on the second floor testified that he heard a crash and started for the west wing, debris was breaking through f... above when he reached there. A workman ... floor above, the third, stated that the fl... sagged under his feet and things fell from ab... at the same time; that he ran up hill to the ... g. A tile-layer on the fourth floor indicated t... olumn he thought fell first.

The contractor and his superintenden... ere on the roof when it fell. Their testimo... s that the center of the building seemed to ... k for about 12 ft. There was no perceptible ... nd of an impact. It went down in the shape ... bowl. The theory of the contractor was that ... break came at about the first floor. The archi... (not an eye-witness of the collapse) stated th... in his opinion some of the supports under the ... floor may have been removed too soon.

The complete destruction of the variou... members of the collapsed portion, both by fall... nd by work of recovering the bodies of those wh... were killed, hopelessly confuse cause and effect, rendering it impossible to determine directly the member at fault. The immediate cause will remain a matter for logical deduction and, to some extent, of individual opinion.

The details here given, in the collation of which the contractors and architect rendered every assistance, will probably enable interested readers to form their own conclusions.

[We add to Mr. Hawgood's report the following extracts from the testimony before the coroner's jury as reported in the Long Beach "Press" and the Los Angeles "Times."—Ed. Eng. News.]

Mrs. H. M. Ward testified that she was standing on the lawn of her residence across the street from the hotel when the bar dropped out of the "H."

"I was looking right at the building," she ... "when the roof began to sink. I do not rec... I heard any crash, but it sank and swayed. I ... men like ants creeping off and I tried to shriek ...

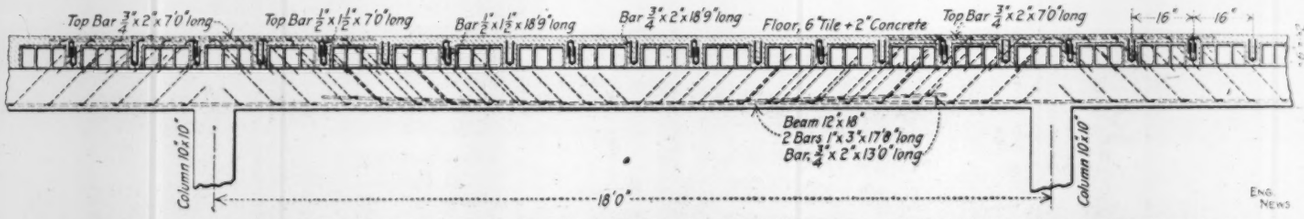


FIG. C. SECTION THROUGH FLOOR AND ELEVATION OF BEAM AT JUNCTION OF STANDING PORTION AND FALLEN PORTION.

FIG. 3. VIEW BETWEEN FIRST AND SECOND FLOORS, LOOKING THROUGH CENTER OF PART THAT FELL.

to h... They seemed paralyzed. The roof finally broke ... commenced falling through; first a story at a ... then in a confused, blurred mass."

D. ..., a negro cement mixer, was within a few feet of t... ding and saw the first crash. "The first thing I ... or was the top. It pitched forward, and it sec... the next floor could not hold the weight." J. ...leman, a carpenter, working on the fifth floor, was ...g a scantling when he heard a crash. He looked and saw the roof commence to fall. The men mixing cement were falling with it. When the roof struck the fifth floor it checked, slightly, and he thought it was going to hold; but it broke through. When it struck the fourth floor there was another check, and the building swayed; it looked as though the entire east wing was going. Then the "H" part broke away from the wings and crashed lower. After that there was little resistance. Coleman testified that the break came at the southeast corner of the "H" and that the roof careened inward toward the light well.

William Behm, superintendent of construction for Mr. Spaulding, the contractor, was on the east side of the center wing when the crash came. No supports were taken out without his orders, and under no condition was the studding taken out under fifteen days. "On the third and fourth floors," said Mr. Behm, "I took out the supports, but before proceeding with the work upstairs supplementary braces were put in." The forms were never removed from the columns of the fifth floor.

W. H. Craig, superintendent of construction for the architect, testified relative to testing the cement. He said every carload was tested, and that two or three were rejected as not suitable for high-class construction work. He expressed the opinion that the cement was not thoroughly hardened when the fifth-floor supports were removed. He had no jurisdiction over this part of the work, but he thought they should have stayed in place at least a month.

The contract does not specify the length of time that the supports shall remain under the green cement. It only requires "forms to be removed after cement is thoroughly set."

C. F. Smith, a carpenter, was on the fourth floor. The top came first, he said. When it struck the lower floors there was a decided vibration as if the upper floors were forcing the others down as they struck.

Several of the men in the center of the building ran and were saved after the upper floors had apparently fallen in.

S. S. McKinley, a plumber, was working on the second floor. He heard a crash and started for the west wing. Debris was breaking through from above when he reached a place of safety. McKinley was not certain whether the first floor sagged before the crash came, but his theory is that the roof fell first.

Then came Ed. Nicholson, the boy who fell six stories and lives to tell the tale.

"I was tamping cement on the roof," he said. "It dropped about 6 ins., quivered, and then went through to the basement. I knew I was falling, but everything about me was going, too. I kept my senses until I had passed the bluff. I seemed to be falling for hours. I think I was only a few feet from the bottom when I shut my eyes. When I started to fall I was standing upright. I landed with my knees pressed against my chin, tangled in a bale of wire. When I hallooed and they came and took the wire and timbers away and let me out. I never heard a sound all the time."

Walter Natch was working on the third floor, and was "thrown out" on the part that fell. The floor sagged under his feet and things fell down onto him from the top all at the same time. He ran up hill for quite a distance; it was like skating over thin ice. Then he was in the wings and the hotel was all down in the basement.

J. C. Austin, the architect of the building, was required to answer a number of questions relative to altering the plans after the original contract was let. He said some changes were made whereby the Kahn system of flooring could be used. This system had been used all over the East and was highly recommended. Further changes were made in the plans, providing for a roof garden at the top of the building.

The jurymen wanted to know how much additional weight this placed on the sixth floor. The architect replied that it made the top floor considerably heavier, but that the ratio of safety of 1 to 4 was retained. The architects figured the columns and the Kahn people the beams and floors.

Mr. Austin said he has been unable to find any evidence that the foundation has moved a particle. If he were to supervise a like building he would watch the removal of the forms very closely.

Pressed for his theory, the architect said that some of the supports under the fifth floor may have been removed too soon.

William E. Hart, foreman of the steel and concrete workers, was on the roof when the building fell. The break came right at his feet. He could not say whether the fifth floor was standing when the top went through. Like the others, he scurried for safety at the first crash. A workman standing less than ten feet from him went down with the roof. Hart testified that the cement in the forms supporting the sixth floor had stood for not less than twenty days.

F. L. Spaulding, contractor, said active work on the building was commenced April 25, and that so far as he had known, the specifications had been closely adhered to. At the time of the accident he was standing on the roof of the building. His attention was first called to the swaying of the floor by the foreman who was standing by.

Mr. Spaulding said the skeleton of the building was of reinforced concrete braced by steel bars. He had never before constructed a building with floors in such a manner as in the Bixby. They were, according to the belief of himself and architects, perfectly safe.

The depth of the foundation was ten feet, and at the bottom was practically the same as at the top, except it was a little more dense. Mr. Spaulding had looked over the ruins since the accident, but thus far had been unable to arrive at any definite conclusion with regard to the real cause of the accident. If the foundation had shifted in any way he was unable to find the least evidence to indicate it.

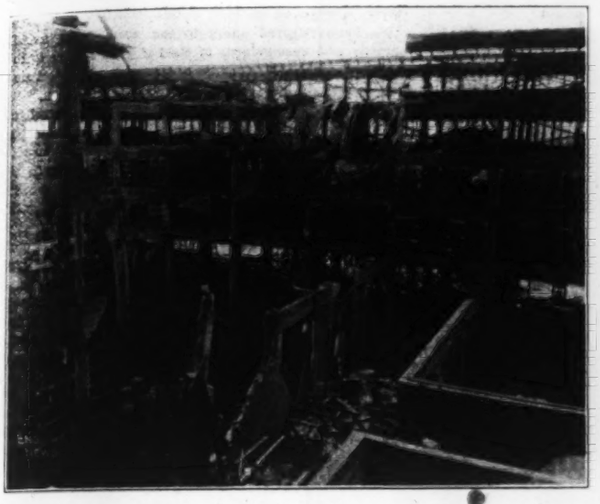
Asked the reason for some of the columns being out of plumb, Mr. Spaulding said he could give none until a more thorough investigation was made. "The roof of green concrete had been in about twenty-four hours before the fall," said he.

"The second floor was started August 2. On August 9 it was complete. There was then an elapse of a week before I started the third. The floors were all finished in about the same time. I was never rushed in the work and up to the time of the wreck the third and fourth floors had about 45 days to solidify.

"I made a thorough inspection of the building twice a week, and have never had occasion to fear that it was going to fall. The first impression I had that something was wrong, was when it sagged under my feet.

"The fifth floor was finished October 22, and work on the roof was commenced about October 29."

J. B. Harris, of the Trussed Concrete Steel Co., of Detroit, said the steel work was sufficiently strong, and that no person could yet account for the accident.



FIGS. 4 AND 5. VIEWS LOOKING TOWARD WEST WING. PART OF THIRD FLOOR SUPPORTING WEIGHT OF FALLEN FOURTH AND FIFTH FLOORS.

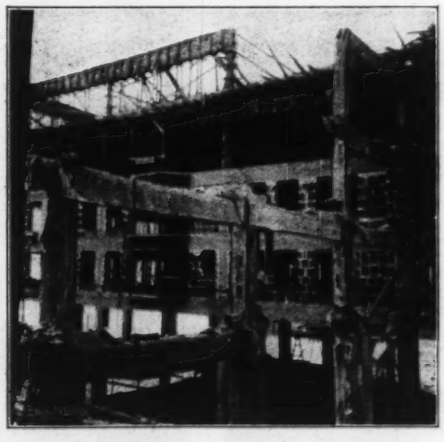


Fig. 6. View Showing Failure of Girders by Shearing.

The verdict of the jury was as follows:

We, the jury, find the men came to their death November 9, 1906, by being crushed by partial collapse of Hotel Bixby, under construction in Long Beach. We find from evidence given that such collapse was occasioned by prematurely removing part of the timbers supporting the fifth floor, and proceeding with construction of the roof before cement beneath was properly cured.

We find no person criminally liable for such fatality.

STEEL RAILS: THEIR COMPOSITION AND CROSS-SECTION.*

By Robert Job.†

Twenty or thirty years ago steel rails did not cause the difficulty which is found with the present product. This condition, which is only too familiar to every railroad man, is due to a number of causes.

In the first place, a vastly greater tonnage is handled to-day by the mills, and the same care is not used in the preparation and cropping of the ingots, while in the rolling much higher finishing temperatures are maintained, resulting in coarser structure with relatively rapid wear. In many cases the composition is better to-day than formerly, yet in spite of what under present practice would be considered dangerous composition, it is a well-known fact that the old rails gave generally excellent service, this being due largely to thorough working of the steel down to a low finishing temperature.

Why is not the former close-grained, slow-wearing structure produced to-day? Is the change due merely to the insistent efforts of the mills for higher tonnage or do other elements enter into the case? The answer is complex. In the first place the increased weight of the present sections of 90 or 100 lbs. per yd. instead of 60 or

*Condensed from a paper read Nov. 16 before the New York Railroad Club.

†Late Chemist, Reading R. R. Co.

65 lbs. has radically upset the ratio between the various components of the area of the rail, that is, head, web, and flange. The former is far thicker and of much greater mass than formerly, while the other parts in many cases have increased but little in thickness or even have decreased. As a result of these changes the flange gets to the lowest temperature at which it can be rolled long before the head reaches the same temperature, so that even though the flange be fine grained and tough, as fine even as was obtained in the old practice, the crystals of steel in the head may be very coarse, since they were growing in size from the time that pressure upon them in the rolls ceased until the steel at that point had fallen below a dull red heat. This condition would mean relative rapid wear and brittleness.

From the above it is evident that in order to get fine grained structure clear to center of head two courses are open. First, to rearrange the proportions of the rail in such manner that each component part shall reach the critical temperature at more nearly the same time, as in the old sections, or secondly, to change the heat treatment given the steel, either during the rolling or subsequently. By the first method the large crystals would be prevented from forming, while by the second, even though formed, they would be broken up by the reheating.

In some of the mills it is common practice to hold the rail before the last pass with the object of giving greater toughness and better wearing qualities to the steel owing to the finishing at a lower temperature. Unluckily the plan is of little benefit, since thereby a fairly fine granular structure is produced to a depth of only about an eighth of an inch from the surface. This, in service, is quickly worn away, exposing the coarse structure beneath.

As an example of the influence of heat treatment after rolling, it may be of interest to detail the results of an investigation carried out several years ago under our direction upon the Reading Railway. Eleven 90-lb. rails of coarse granular structure were, through the kindness of the Pennsylvania Steel Co., sawn in halves and one-half of each run into a reheating furnace, brought to a cherry red, and at once removed and let cool in the air. In the annealed rails the coarse granular condition was entirely obliterated and replaced by a very fine structure of great toughness. These twenty-two rails were laid in track at Reading at a point where they were subject to slow, heavy traffic. All of them were in the same line, laid alternately, first an annealed rail, and then its untreated half. From time to time measurements were made of the contour with a rail indicator. After being subject to a traffic of approximately 88,128,000 tons we were surprised to find that the annealed rails showed 31.9% the more rapid wear, while they also showed the greatest tendency to mash down and splinter. The average loss of weight was 2.85 lbs. per yard for the untreated rails and 3.77 per yard for those treated. Upon cutting out strips from the heads and subjecting to tensile test we found the following averages:

	Natural.	Annealed.
Tensile strength, lbs. per sq. in.....	129,700	126,100
Elastic limit, lbs. per sq. in.....	80,600	70,225
Elongation, 2-in. section.....	21%	22%

The composition averaged about as follows:

Carbon	0.540%
Phosphorus	.079%
Manganese	1.060%
Sulphur	.080%
Silicon	.090%

The clear teaching of the trial was that under heavy traffic high elastic limit is essential to the best service, and it was also evident that if one proposes to get greater toughness and safety by some treatment, like the annealing, which lowers the elastic limit, one should also, to get the best results, increase the carbon or manganese contents to the point at which the elastic limit will be high enough to resist crushing, even though the steel be somewhat unsound. In other words, the toughness and elasticity produced by the fine granular structure permit one to increase the hardening contents considerably beyond the point which otherwise would be safe, thus obtaining greater capacity for wear.

A good deal of discussion has arisen from time to time concerning the effects consequent upon overloading of rails, and in some instances we have heard manufacturers attribute the crushing down and splintering of their product to the heavy wheel loads now prevalent.

The appearance of the fracture of a rail which has failed owing to overloading is distinctive. The fracture generally takes place immediately over a tie, due, of course, to the repeated straining of the metal beyond its elastic limit. At first, merely a hair cra... This, with repeated bending, gradually exte... rail and the broken surfaces become smooth... ened by oxidation. Finally, the remainin... too slight to support the weight of a p... and the final fracture occurs. We have ... of these light rails from track, broken ... the drop, and found one of these typical crac... ing over each tie, showing clearly the nec... watchfulness in the maintenance of track s... heavy traffic.

We have referred above to the necessity o... porosity and unsoundness of steel if good servi... obtained. Curiously enough a frequent charac... nickel steel is somewhat allied to this condit... a matter of general observation that nickel ... have not given the service which was anticip... hoped for, but that there has been a tendency ... and to have a life not all proportioned to the co... Several years ago while investigating some of th... we came upon a condition which seemed to accou... for this unfortunate behavior. An 80-lb. nickel-... having 3.48% of nickel was lightly etched and a ... of dark spots appeared. These we found were no... cles of slag or oxide due to failure to crop the in... clear metal, for the steel was thoroughly sound. The spots had a silvery appearance and were exceedingly hard, and evidently were either pure nickel or else an alloy high in nickel. The important point was that the metal was not homogeneous, and at these places appeared to be imperfectly welded, so that under severe stress the effect would be the same in a way as though the line of hard alloy had been a line of slag. There would be an imperfect bond and the surfaces would slip apart and slivering would result.

The important question remains: How can better rails than are now secured be obtained? We have already suggested that by modifying the section of the rail a finer granular form with its inherent toughness and tenacity may be obtained. By insisting upon cropping of ingots clear to sound metal, and by testing a rail-butt which is with certainty known to have been taken from the top of an ingot, so that if marked unsoundness be present, the heat may be rejected by the drop test, a reasonable degree of soundness can be secured, and slivering and crushing largely prevented. By increasing the hardness of the rail as much as is compatible with the character of the roadbed, the rate of wear may be decreased, but we believe that further aids are necessary and can before long be obtained. The Bessemer rail has filled an important need, particularly in the days of light, easily rolled sections and light wheel loads. Under present conditions, however, there is urgent demand for harder, tougher steel. In the Bessemer rail the hardness, with the proportion of phosphorus usually present, cannot be increased much beyond present practice, say 0.60 or 0.65% carbon, without causing undue brittleness, and hence advantage has been taken of the basic open-hearth process by which phosphorus and sulphur can be nearly eliminated. With these elements of brittleness largely removed the proportion of carbon has been increased safely and with very favorable results to nearly 0.90%, thus securing great hardness, together with great tenacity and a very low rate of wear. Bessemer rails will undoubtedly continue to be used for the lighter sections and in locations where traffic is light, but we believe that under the more exacting conditions this quality will before long disappear, replaced by the harder, tougher steel of the basic open-hearth process.

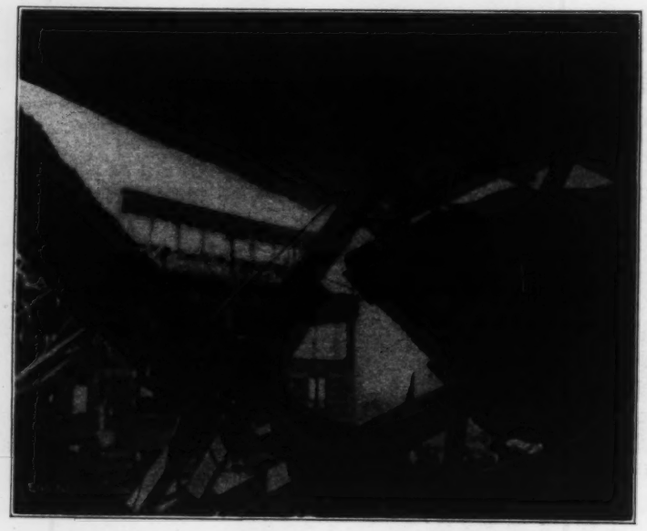


FIG. 7. VIEW OF UNDER SIDE OF PART OF FOURTH FLOOR.

FIG. 8. PROPS SUPPORTING CENTERING BETWEEN FIFTH FLOOR AND ROOF IN PART LEFT STANDING.

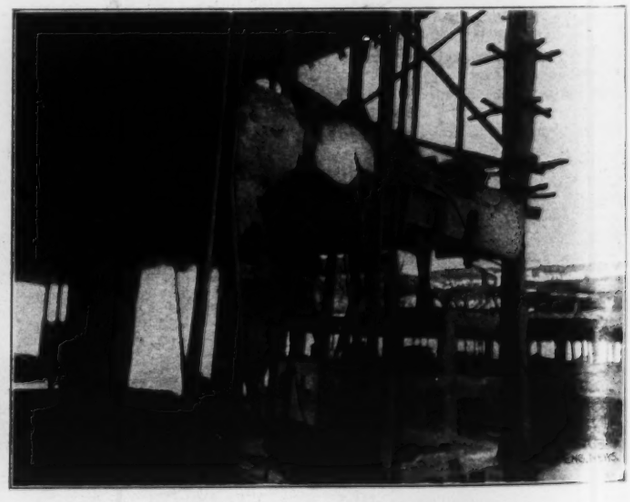


FIG. 9. VIEW AT EDGE OF BREAK.

A MECHANICALLY-POKED CONTINUOUS GAS PRODUCER.

A sectional view of the Hughes mechanically poked continuous gas producer is shown in the accompanying figure. The shell of the producer consists of riveted steel plates mounted upon a cast-iron base ring. To this ring in turn is bolted a cast iron water seal and ash receptacle. The whole thing is mounted upon a turn-table, which rotates the producer when it is in operation. The turn-table is fitted with a steel tread that runs upon conical wheels, this arrangement keeping the table horizontal and the producer vertical. The circumference of this table is provided with gear teeth, that mesh with a pinion gear, which in turn is driven by a train of gears. This train of gears, which drives the mechanically operated poker as well as rotating the producer, is connected with the motive power that operates the machine. This gearing is supported by a steel framework securely braced to the top of the producer. A blast inlet pipe, with a cast iron deflecting plate, passes through the base.

The steel shell of the producer is lined with fire-brick, while the cast steel top is provided with a double flange, which permits of water cooling and gives a water seal between the top and shell, as shown in the cross section. This top is equipped with two feed hoppers, fitted with counter balanced bells and gas-tight swing covers, located at different distances from the vertical axis of the producer. This arrangement deposits the coal upon the fire in two concentric rings, since the top of the producer remains stationary while the body rotates, thereby facilitating its more uniform distribution by the mechanical poker. A gas outlet, lined with fire-brick and provided with cleaning door, peek holes, etc., is also attached to the stationary top.

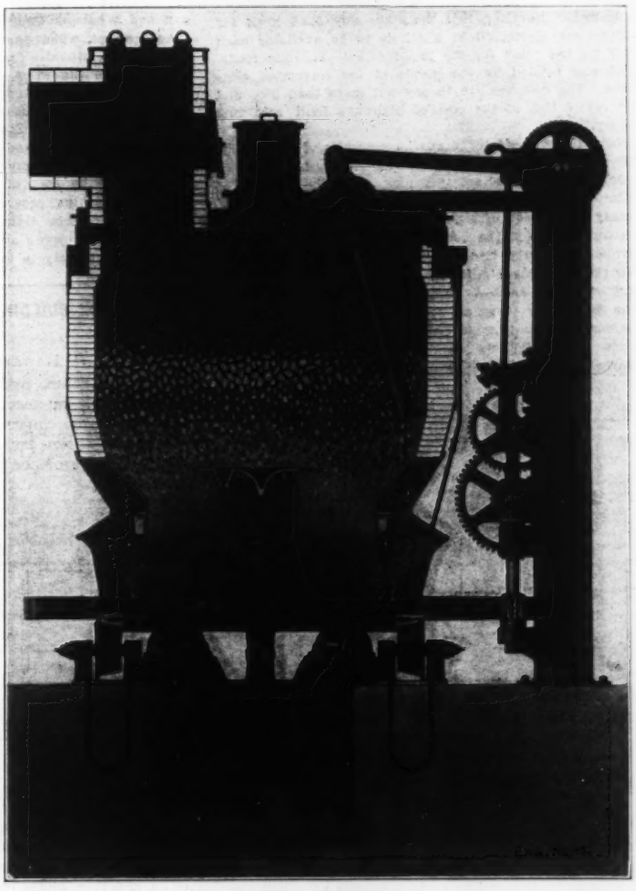
The poker, which is a water-cooled steel casting, is suspended from the producer's stationary cast steel top by a trunnion. A crank and crank shaft driven by the above-mentioned train of gears, actuate a ratchet and gear that operates the poker. This mechanism moves the poker back and forth in the coal, agitating and breaking up the mass of coal, at the same time working down the ashes and distributing the coal very uniformly over the fire.

These machines are driven by either direct or alternating current electric motors, the power required to operate a standad size producer, 10 ft. internal diameter, being 3 HP.

The labor required to attend to these producers in plants where the coal is fed to the producer from overhead bins by mechanical devices is about one man for one or two producers, depending on the arrangement of the plant.

It is claimed that the uniform treatment, secured by the mechanical poker, gives better and more uniform results as regards quality, quantity and supply of gas, thus reducing the number of producer units required for a given capacity. Under average conditions the capacity of the mechanically poked producer is said to average 25 lbs. of coal per hour per sq. ft. of producer area, while it frequently runs as high as 30 lbs. It is further claimed that an average uniform quality of gas, of the following composition by volume may be maintained when using bituminous coals: Carbon dioxide (CO_2), 4%; carbon monoxide (CO), 26%; hydro-carbons, 3% to 4%; hydrogn (H), 13%; nitrogen (N), 53%.

These gas producers are manufactured exclusively by the Wellman-Seaver-Morgan Co., of Cleveland, O., to whom we are indebted for the above information.



SECTIONAL VIEW OF HUGHES MECHANICALLY-POKED CONTINUOUS GAS PRODUCER.

The Wellman-Seaver-Morgan Co., Cleveland, O., Makers.

ROAD LEGISLATION IN THE UNITED STATES IN 1905.*

By M. O. Eldridge.†

During 1905, 147 bills touching various phases of road administration were enacted into law by the Legislatures of 31 States. A brief synopsis of over 100 of the most important of these measures is given below. [Not all included here.—Ed.]

A constitutional amendment providing for the expenditure of $50,000,000 by the State of New York for permanent road improvement during the next ten years has been ratified. The Pennsylvania Legislature has organized a state highway department and appropriated over $6,000,000 to be expended during the next six years on permanent road work. The States of Illinois, Idaho, Michigan, Maine, New Hampshire and Washington have formally adopted state aid laws and a state highway commission has been created in Minnesota. It will be seen, therefore, that the principle of cooperation between the states and the civil subdivisions thereof is meeting with popular favor throughout the country, and that appropriations for this work are greater and more numerous than the most enthusiastic advocates of the plan ever contemplated.

A large number of bills have been enacted in various states to enable counties and townships to increase taxes or issue bonds for road purposes, while many important measures have been enacted which provide systematic and businesslike methods of road administration. Among the latter the most notable are the new supervisors law of Pennsylvania, the county and township road law of Indiana and the county supervision system of Oklahoma.

The use of motor vehicles has increased so rapidly that 18 states have adopted measures which require that automobiles be registered, numbered and provided with lights, brakes, bells, horns or other signals, and speed limits have been fixed so as to protect the interest of other users of the highways.

CALIFORNIA.—An act was passed regulating the operation of motor vehicles and an appropriation made of $20,000 to carry the same into effect. Franchises may be granted for the construction of roads to be used exclusively by horseless vehicles.

An act passed March 22, 1905, provides for the construction of a public highway from the General Grant Park in Fresno County easterly a distance of about 50 miles to King's River canyon, and appropriates about $25,000 for its construction. An appropriation of $5,000 was also made for guideposts to be erected on the deserts in certain counties.

CONNECTICUT.—The annual appropriation for state aid was increased from $225,000 to $220,000. Several amendments were made to the original act, the most important of which are as follows: The Highway Commission is authorized to build roads through towns provided the towns fail to do so under the state aid law, and the interests of the state require such action in connecting trunk line roads now under construction. The total cost to be paid by the state for this work in any one year is not to exceed $25,000, but the town's share for such improvement shall be deducted from any subsequent appropriation. The State Highway Commission is also authorized to employ engineers to make surveys and prepare plans.

DELAWARE.—The state aid law was repealed ('05 ch. 139) and an act passed in its stead providing for state aid in Newcastle County.

FLORIDA.—In counties where hard roads have been built or may hereafter be built, two-horse vehicles shall have tires not less than 4 ins. wide; four-horse vehicles shall have tires 6 ins. wide; but where such vehicles are used to haul heavy loads the width of tires shall be 7 ins.

IDAHO.—An act approved March 8, 1905, provides for the construction of a system of wagon roads and trails in the mountain regions and for the appointment of an intermountain wagon road commission, to consist of three persons, of which the Governor shall be ex-officio member and chairman. Roads constructed according to this act are to be maintained by the counties in which they are located.*

ILLINOIS.—An act approved May 18, 1905, provides for the establishment of a state highway commission composed of three persons to hold office for two years. This commission is to investigate and carry on experimental work in road building, to determine the best and most economical methods on road construction, and to advise with local officials relative to the construction and maintenance of roads and bridges. The commissioners are to receive no compensation, but their expenses are to be paid. The commission is authorized to appoint a state engineer who is to receive a reasonable salary and actual traveling expenses. Clerical and other assistance is also provided for. The sum of $25,000 a year was appropriated to carry out the provisions of the act.

INDIANA.—Boards of county commissioners are authorized to improve roads within their counties upon petition of a majority of the adult resident landowners. The commissioners are required to appoint a superintendent under whose direction said roads are to be built, the work to be done by contract. The cost of the roads is to be assessed on all lands in proportion to the benefit derived from the improvement. Bonds may be issued to cover the cost of such roads provided the landowners agree to pay the same in 10 yearly instalments, with interest at 6%.

Section 65 provides that upon petition of 50 or more freeholders and voters of any township, the boards of supervisors of the counties are authorized to establish or improve any road within the township. The appointment of a competent civil engineer and two viewers to pass upon the advisability of the improvement and to prepare plans, specifications and estimates of the same is provided for. Upon the approval of said plans and specifications by the board of commissioners, an election is to be held at each voting place in the township to determine whether the proposed road shall be built. The work is to be done by contract and to be paid for out of money received from the sale of bonds, payable in not less than 10 nor more than 20 years. The board of commissioners is authorized to levy a special tax upon all the property in the township, including cities of 30,000 inhabitants or less, to pay the interest and principal. It is also authorized to employ a competent superintendent to supervise the construction of

*Condensed from Review of Legislation, 1905, published by the New York State Education Department, New York State Library, Albany, N. Y.

†Chief of Records, Office of Public Roads, U. S. Department of Agriculture, Washington, D. C.

[*See Eng. News, March 15, 1906, for outline of this act and of work already started thereunder.—Ed.]

such roads. Bonds or other evidences of indebtedness are not to be issued for any purpose in excess of 4% of the total assessed valuation of the township in which the roads are located.

KANSAS.—An act approved March 1, 1905, provides that the township board, consisting of the trustee, clerk and treasurer of each municipal township in the state, be made commissioners of roads and highways of their respective townships, and that all roads are to be under their control except those located in cities of more than 600 inhabitants. The commissioners are authorized to appoint one or more road overseers who are to serve two years and receive $2 a day for time actually employed. The commissioners are empowered to let by contract any road work. A levy of not more than 5 mills on $1 on all property in the township is provided for out of which to pay for the construction and maintenance of roads and bridges, such tax to be paid in cash unless the commissioners agree that it may be worked out.

MAINE.—An act approved March 24, 1905, provides for the appointment by the Governor of a commissioner of highways who shall be a civil engineer, and who is to receive an annual salary of $2,500. Actual traveling expenses, assistants and clerks are also provided for. The commissioner is to compile statistics and make investigations regarding the improvement of the highways of the state and to disseminate information regarding the best and most economical methods of building and maintaining roads and bridges. An act approved March 4, 1905, provides that towns may receive from the state one-half of the amount actually expended in the permanent improvement of state roads, not exceeding $300 a year. This aid is not to be extended to any town unless it has expended at least $100 exclusive of and in addition to the amount regularly raised in such town for highways or bridges, and not until the county commissioners shall have inspected the roads so improved and certified to the Governor and council the sum which the said town is entitled to receive from the state.

MICHIGAN.—An amendment to the Constitution provides for state aid in the improvement of public roads. A state highway department was created by the appointment of a commissioner and assistants, whose functions are to instruct, to inspect and to reward. A system of rewards by the state was inaugurated, to be paid to townships and counties which build gravel or macadam roads—$250, $500, $750 and $1,000 a mile according to the kind of road built, when the same has been approved by the State Highway Commissioner.

MINNESOTA.—A state highway commission of three members ('05 ch. 163) was provided for, to serve without compensation. A state engineer with salary of $1,800 a year shall act as secretary of the commission. In all counties having a population of 150,000 or more all road taxes are to be paid in cash. The electors of the towns may authorize the issuance of bonds for road improvement. Such bonds shall be payable within 20 years from the date of issue and shall not bear more than 6% interest.

MISSOURI.—In all counties containing 120,000 and less than 175,000 inhabitants, the office of supervisor of roads and road overseers is created for a term of two years at $1,800 a year. In all counties having a population of more than 150,000 and less than 400,000 inhabitants, the county court shall annually set apart from the road fund derived from licensing dram shops a sum sufficient to keep all the macadamized roads in said county in good repair.

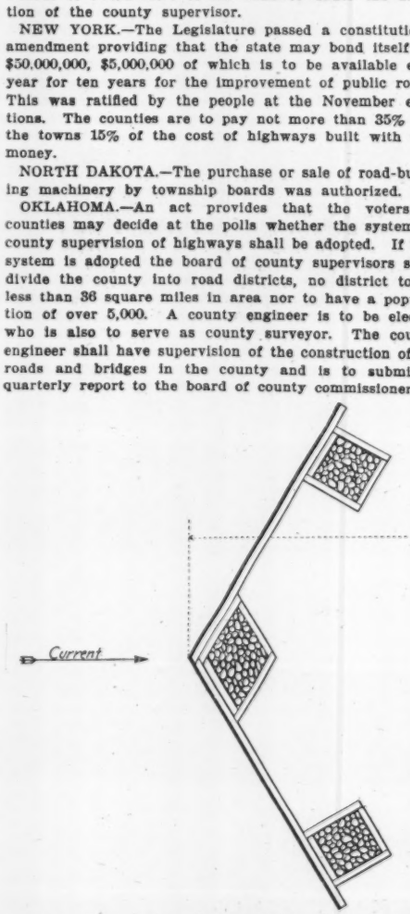
NEW HAMPSHIRE.—An act provides for state aid in road improvement. The Governor and council are authoried to appoint and fix the compensation of a state engineer and assistant. Towns and counties shall set apart certain amounts for permanent improvement of highways, varying inversely as the assessed valuation of property from 25 cts. to $1 on each $1,000 of valuation. If any city, town or place desires aid it shall set apart an additional sum equal to 50% of the amount as above assessed. The Governor and council are empowered to apportion to places desiring state aid amounts varying from 20 cts to $3 for each $1 assessed and raised for state aid, the proportion increasing inversely as the assessed valuation of property. Upon application of any town or place the Governor may furnish free of charge the services of an engineer for consultation and advice on road matters. All work paid for out of joint funds shall be under specifications issued by the Governor and council and shall be done by contract. All highways made by means of the joint funds shall be maintained by the city, town or place in which located, in default of which repairs will be made under the direction of the Governor and council at the expense of the state and the cost added to the state tax for that town or place for the next year. The act appropriates $125,000 annually for six years for the permanent improvement of highways, amounts not used in any one year to be cumulative. The state highways shall be constructed and maintained and all necessary changes shall be made under the direction of the Governor and council, the expenses to be paid out of the money appropriated by the state under this act. The Governor and council shall have surveys and plans made for all state highways deposited with the Secretary of State.

NEW JERSEY.—The Board of Chosen Freeholders of any county may permanently improve roads. They may require the townships through which the road runs to pay 10% of the cost of improvement and cause surveys and plans to be made which shall be approved by them and the State Highway Commissioner. One-third of the cost of such roads is to be paid by the state. The state aid for any one year is limited by law to $400,000, to be apportioned among the counties by the Governor and State Highway Commissioner. The county expenditures for such roads are limited to one-half of 1% of the ratables of the county. The appointment by the State Commissioner of a county supervisor to take charge of the work done under this act is provided for. The Boards of Freeholders may issue bonds for two-thirds of the estimated cost of the work, which may run from 6 to 30 years with interest at the rate of 5%. Roads constructed under this act must be maintained by the Boards of Freeholders of the counties under the direction of the county supervisor.

NEW YORK.—The Legislature passed a constitutional amendment providing that the state may bond itself for $50,000,000, $5,000,000 of which is to be available each year for ten years for the improvement of public roads. This was ratified by the people at the November elections. The counties are to pay not more than 35% and the towns 15% of the cost of highways built with this money.

NORTH DAKOTA.—The purchase or sale of road-building machinery by township boards was authorized.

OKLAHOMA.—An act provides that the voters of counties may decide at the polls whether the system of county supervision of highways shall be adopted. If this system is adopted the board of county supervisors shall divide the county into road districts, no district to be less than 36 square miles in area nor to have a population of over 5,000. A county engineer is to be elected who is also to serve as county surveyor. The county engineer shall have supervision of the construction of all roads and bridges in the county and is to submit a quarterly report to the board of county commissioners.



OREGON.—County courts are authorized to permit the building of experimental roads in the various counties by the United States Government under such terms and conditions as such courts may deem just and proper. They are also authorized to lay out, construct, relocate and maintain roads, such work to be done by contract under the direction of the roadmaster of the county, or such other competent person as may be appointed for the purpose by the county court. The roads are to be paid for in ten annual instalments by an assessment on all abutting property within two miles of the roads in proportion to the benefits accruing to such property.

PENNSYLVANIA.—An act approved May 1, 1905, provides for the establishment of a state highway department, consisting of one commissioner at $5,000 a year, one assistant commissioner at $3,000 a year, six civil engineers at $2,000 each a year, draftsmen, clerks, stenographers, etc. A system of cooperative road building between the state, counties, the townships and in some cases the boroughs, is provided for: 75% of the cost of the roads to be paid by the state, 12½% by the county and 12½% by the township. The state aid fund is apportioned among the counties or townships in proportion to road mileage. County roads, when improved according to the standard fixed by the State Highway Department, may receive the same aid from the state as state highways. All state aid work is to be done by contract. Ten per cent. of all state aid funds are to be used for maintena... of state highways and such other improved roads as ...ve been built according to the standard state specifica... s. This aid is distributed in proportion to the mile... of said improved roads, but must not exceed one-half ... the annual cost of maintenance. To pay the state ... are for the construction and maintenance of these ro... $5,356,232 was appropriated; $856,232 for 1905, $1,... for 1906, $1,250,000 for 1907, $1,500,000 for ... and $1,500,000 for 1909. The townships' share is ... be paid for by a special cash levy or by the issuan... of bonds provided for by law.

An act provides that the State Highway D...rtment shall repair that portion of the old Cumber... road which lies within the state and that no tolls ... hereafter be collected thereon. An appropriation o... was made for the purpose.

WASHINGTON.—The appointment of a state ...ighway commissioner was provided for, at a salary o... a year. He is to have charge of the laying out, ...nstruction and maintenance of state highways. Th... sum of $10,000 is appropriated to pay the salary and ...penses of the Commissioner. An additional sum of ...00 is appropriated for the purpose of building roads in Okanogan and Whatcom Counties.

Another act, which passed the legislature over the Governor's veto, provides for the establishment and repair of certain state highways. A state highway board, consisting of the State Auditor, State Treasurer and Highway Commissioner, was also created. One-half the cost of roads built by the State Highway Commissioner is to be paid by the state and one-half by the counties.

WISCONSIN.—An act provides that counties may pay one-half of the cost of permanent roads built in the various townships, provided the same be constructed according to certain standards stated in the bill. The funds for this purpose are to be provided by a levy upon all taxable property in the county.

A PLAN FOR BUILDING COFFERDAMS FOR RIVER PIERS.

By C. P. Howard*, M. Am. Soc. C. E.

The cofferdam and breakwater or "Current Deadener" here described was used some years ago during the construction of the Georgia, Carolina & Northern Ry. (Seaboard Air Line). The writer was informed by the Chief Engineer, the late Major R. H. Temple, that it constituted his general plan of foundations; meaning, of course, for piers of bridges in running streams, or work of a similar character, where cofferdams were necessary. Major Temple was employed on the St. Charles bridge across the Missouri River, and later was Chief Engineer during the construction of the Richmond & Allegheny, Georgia Pacific, Georgia, Carolina & Northern, etc., all in the South, and as far as known to the writer, this general plan of cofferdam has never been published. In addition to the bridges across Broad and Savannah rivers, in South Carolina and Georgia, on the Seaboard Air Line, work with which the writer was personally connected, he is informed that the same general plan was used at the following structures:

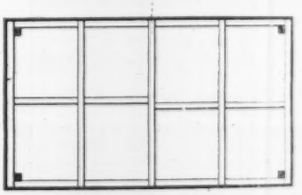


FIG. 1. SHOWING POSITION OF CURRENT DEADENER IN RELATION TO COFFERDAM.

Coosa River, Ala., Georgia Pacific Ry.
Coosa River, Ala., Central R. R. of Georgia.
New River, Radford, Va., N. & W. Ry.
James River, Va., Rope Ferry Bridge, C. & O. Ry.
Dan River, Va., Milton & Sutherlin R. R. (narrow gage).
New River, Va., Highway Bridge, Va. B. & I. Co.
Neuse River, N. C., Highway Bridge, Va. B. & I. Co.

The essential feature of the design (Fig. 1) is the breakwater or current deadener. This in practice has proved a perfect success. It creates a dead eddy, permitting the use of a single wall cofferdam or crib with ramp of earth surrounding.

*Consulting Engineer, Empire Building, P...sburg, Pa.

The [illegible] cribs of the breakwater (Fig. 2) with the waling pieces for sheet piles can be made of round timbers. It is not necessary to use drift bolts for the cribs. With holes in side pieces bored beforehand by template, and a long pointed iron rod extending up from the bottom of crib at each corner, the side pieces can be strung on like beads on a string. As soon as the bottom of the cribs with corner rods and a few side pieces are put together they can be floated out, sunk and completed in place. The center crib can be built square instead of diamond-shaped, though the latter might offer better support to the waling pieces in case they were inclined to be flimsy.

At Broad and Savannah rivers no attempt was made to get clay for puddling. Sandy loam, or ordinary river bank material was used.

While saving the outside wall of timbers, this plan requires more earth filling than the ordinary double wall cofferdam, but this is not necessarily a disadvantage. The thickness at the base and the cubic yards of filling increases rapidly with the depth, but so does the water pressure which the filling must resist.

The various details of plan, size of cribs, length of wings, thickness of sheet piling, etc., will, of course, vary with the size and depth of foundation. The embankment, or earth filling, can sometimes be brought from the river bank by wheelbarrows on plank runways supported from the bottom by small trestle bents or "horses." At other times scows will be necessary. By stretching a few long timbers from the cribs to the main cofferdam, a convenient working platform is secured for hoisting machinery, mortar boxes, etc.

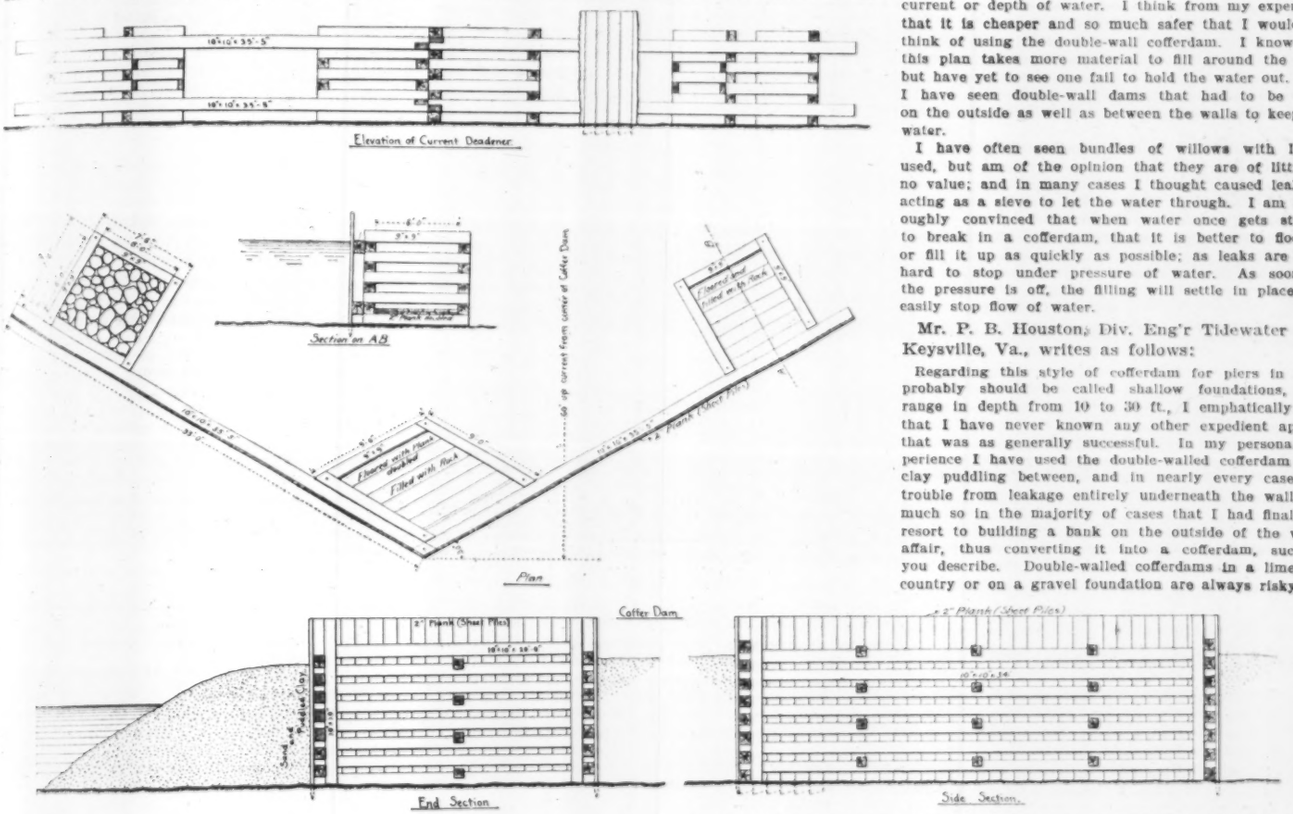


FIG. 2. DETAILS OF 20 x 34-FT. COFFERDAM AND CURRENT DEADENER.

As far as known to the writer, the entire mechanical work of putting in the foundations at all the bridges mentioned, framing, earth filling, excavating, pumping, etc., was done by W. M. Cardwell, of Ringgold, Va. The following comments from his son, Mr. F. F. Cardwell, Lake, N. C., are of interest:

The advantage I have found in using this plan of single cofferdam and breakwater is that the timber is cheaper and can be placed much quicker than the double cofferdam. These cribs and breakwater timber can be used in shape of round logs as they come from the woods, with only a few drift bolts to fasten them together. In running or swift water it will make a complete eddy around the cofferdam, if the piling on breakwater is properly put on.

On the Georgia Pacific bridge at Riverside, Ala., there were three deep foundations 20 to 30 ft. below low water; and here we used clay and also sand mixed with silt of sandy loam. I am of the opinion that bank sand and silt such as river banks are composed of is better than clay. On Columbus & Western (Central of Georgia) at Childersburg, Ala., we used sand and silt just as it was found in the river bank, and it proved very successful. The water here was 18 to 27 ft. deep.

I do not think it is safe to use the double-wall cofferdam in limestone countries. So many underground pockets are found sometimes that they give considerable trouble with the double-wall dam. With the single-wall dam the bank spreads at the base, and it is easier to find leaks that break in through the underground passages.

I am of the opinion that this is the cheapest plan of cofferdam and quickest to put in where there is any current or depth of water. I think from my experience that it is cheaper and so much safer that I would not think of using the double-wall cofferdam. I know that this plan takes more material to fill around the dam, but have yet to see one fail to hold the water out. And I have seen double-wall dams that had to be filled on the outside as well as between the walls to keep out water.

I have often seen bundles of willows with leaves used, but am of the opinion that they are of little or no value; and in many cases I thought caused leakage, acting as a sieve to let the water through. I am thoroughly convinced that when water once gets started to break in a cofferdam, that it is better to flood it or fill it up as quickly as possible; as leaks are very hard to stop under pressure of water. As soon as the pressure is off, the filling will settle in place and easily stop flow of water.

Mr. P. B. Houston, Div. Eng'r Tidewater Ry., Keysville, Va., writes as follows:

Regarding this style of cofferdam for piers in what probably should be called shallow foundations, that range in depth from 10 to 30 ft., I emphatically say, that I have never known any other expedient applied that was as generally successful. In my personal experience I have used the double-walled cofferdam with clay puddling between, and in nearly every case had trouble from leakage entirely underneath the walls, so much so in the majority of cases that I had finally to resort to building a bank on the outside of the whole affair, thus converting it into a cofferdam, such as you describe. Double-walled cofferdams in a limestone country or on a gravel foundation are always risky.

The breakwater or current deadener is an essential part of the single-wall dam in running water, and the one you describe acts charmingly. I have used this entire method in railroad work and also in the United States river improvement service on the Arkansas River, where extensive areas of the river bed had to be exposed in order to deepen the channel.

In conclusion, I would say, that this method is generally more economical than any other for two reasons. (1) the materials used are generally at hand and therefore cheaper; (2) the desired results are much more certainly obtained within a reasonable time.

THE COST OF CAR REPAIRS on the lines of the Harriman System has averaged $2.42 per car per month for 11,704 steel freight cars, and $3.74 per car per month for 10,641 wooden freight cars. These figures are the averages of records covering a period of 17 months.

TWO RAILWAY STEAM MOTOR CARS recently built by Manning, Wardle & Co., to the designs of Mr. R. Cronin, Superintendent of Motive Power of the Dublin, Wicklow & Wexford Ry., of Ireland, are of the combination type in which the rear end is carried by an ordinary passenger car truck, while the steel sills are extended at the forward end to carry a pivot bearing on a small four-wheel, outside-cylinder tank locomotive. The car can seat 55 passengers, and has a small baggage compartment; the latter is at the rear and has apparatus for controlling the engine when the machine is being run backward. It has steam heat and incandescent oil lamps, and is designed for a speed of 30 miles an hour, and to have two trail cars.

Length of body	45 ft. 0 ins.
Length over all	63 ft. 0 ins.
Width of body	9 ft. 6 ins.
Boiler	Locomotive type
Steam pressure	175 lbs.
Coal	2,240 lbs.
Water	600 gallons
Weight	42 gross tons

ELECTRIC TRACTION IN THE SIMPLON TUNNEL.*

The completion of the Simplon Tunnel was noted in our columns over a year and a half ago.† It was not, however, until the end of 1905 that negotiations were completed with Messrs. Brown, Boveri & Co. for the installation of equipment for working the traffic. The present article gives some particulars of the installation which, on account of the adoption of the three-phase system and the importance of the service, is of considerable interest.

Fig. 1. Entrance to the Simplon Tunnel at Brigue, Showing the Pole Line Construction.

THE OVERHEAD CONDUCTING SYSTEM.—Two of the conductors for carrying the three-phase current to the locomotives are overhead, and the track rails constitute the third conductor. Outside the tunnel the overhead line is mounted on steel cross-wires suspended between steel poles. These poles are braced at curves as shown in Fig 1, which represents the entrance to the tunnel at Brigue.

In the tunnel the cross-wires are held by gun-metal studs, cemented into the face of the tunnel. The cross-wires are insulated from the studs by porcelain insulators and are drawn tight, but no strain insulators are used. On straight portions of the line the cross-wires are spaced about 83 ft. apart; around curves, about 42 ft. apart. Owing to the constant temperature in the tunnel, the conductors can be drawn very tightly and the sag is very small even in the 80-ft. spans.

Insulators made partly of porcelain and partly of ebonite are used to hold the conductors to the cross-wires. The ebonite portion is in the form of a bolt, to which the conductor is attached. The bolt is carried by a gun-metal cross-piece fixed at each end in strong porcelain insulators by means of hemp and asbestos. The insulator is carried in a gun-metal fitting, by means of which it is attached to the cross-wire. Each insulator will withstand 40,000 volts, although the working pressure is but 3,300 volts.

The conductors in the tunnel have a sectional area of 0.15 sq. in.; those outside the tunnel measure 0.0775 sq. in., the former being larger to keep the drop in pressure over the 12 miles of line within the proper limits. Each conductor in the tunnel consists of two wires.

It was considered preferable to employ two wires per conductor rather than one wire of larger diameter, first, because the smaller wires are far more easy to handle; second, because two wires per conductor ensure a better contact on the bow collectors; and, third, because their diameter of 0.315 in. is the largest in general use for overhead contact wires, and it is possible to obtain wires of this diameter which are thoroughly homogeneous and uniformly hard. In addition to these advantages, the supply is not interrupted if one of the wires breaks, for current can still be supplied by the second conductor until pressure can be taken off the line and the damaged conductor replaced. In order to equalize the wear on the bow collectors as much as possible, the overhead conductors are not kept exactly parallel to the track rails along their whole length, but are arranged to zig-zag slightly on the cross wires.

The track rails are electrically connected with a plastic bond, no copper connections being used. The ordinary fish-plates conduct the current from one rail to the next and the conductivity of the bonds is said to be as good as that of the homogeneous rails.

THE LOCOMOTIVES.—The locomotives are of the bogie type with five axles, three of which are driven by the motors. The two motors are mounted between the three pairs of driving wheels, and both drive the middle axle by means of a bar which couples them rigidly together. The middle axle drives the other two axles by means of a coupling-rod. The motors, therefore, are gearless; they were not directly keyed to the driving axles on account of the difficulty of dismounting them. Further particulars regarding the locomotives* are given in the annexed table:

Overall length (between buffers)	40 ft. 6 ins.
Distance between centers of bogie axles	31 ft. 10 ins.
Distance between centers of outside driving axles	16 ft. 1 in.
Distance between centers of bogies	23 ft.
Diameter of the driving wheels	5 ft. 4½ ins.
Diameter of the bogie wheels	2 ft. 9½ ins.
Weight on the driving wheels	42 tons.
Weight of the mechanical portion of the equipment	34 tons.
Weight of the electrical portion of the equipment	28 tons.
Total weight of locomotive, complete	62 tons.
Rated full-load output of the two motors together	900 B. HP.
Maximum output of the two motors together	2,300 B. HP.
Weight of each motor complete with its coupling bar	10¾ tons.
Normal speeds of the locomotive	42 miles and 21 m. p. hr.
Draw-bar pull of locomotive at 42 miles per hour	7,700 lbs. normal. 20,000 lbs. maximum.
Draw-bar pull of locomotive at 21 miles per hour	13,500 normal. 31,000 maximum.

The control of the motors is effected by means of rotor resistances in combination with altering the number of stator poles.

By working with two combinations of stator poles and rheostatic control it has been possible to reduce the weight of each motor by about 2½ tons, and it is thought that these motors are the lightest which have yet been constructed for their output. Each motor is completely enclosed to protect it against the bad climatic conditions of the tunnel, the hot air of which is mostly saturated with moisture.

Current is collected by means of the bow collectors from the overhead conductors, from which, after passing the lightning arresters, it is led to the line switches and then to the emergency switch, which connects the roof of the locomotive. From this the current passes directly to two bus bars and then through the main reversing switch, which controls the direction of rotation of the locomotive. Then they pass to the main switch, and finally to the motors themselves. The three-phase is brought in, as has been already mentioned, from the track rails, and just as with the single-phase the current passes through the reversing switch and the pole-changing device before reaching the motors.

An interesting detail in connection with the control of the rotor resistances is that they are artificially cooled by means of four blowers, placed in pairs at each end of the locomotive. These blowers are operated by means of small three-phase motors connected to the rotor circuits of the motors. Thus, the blowers start up when the main motors start, and when the latter are at full speed they are automatically thrown out of circuit, for ventilation of the resistances is then no longer required.

Two bow collectors, arranged as shown in Fig. 2, are provided for taking the current from the overhead conductors. Each collector consists of two parts, the upper being the collector proper and the lower a hinged frame to which is pivoted the upper part.

The collector is so arranged that on the outside tracks, where the overhead conductors are 17 ft. from the ground, the upper part of the collector alone comes into action, while in the tunnel, where the height of the overhead conductors from the ground is reduced to 15 ft. 9 ins., the main frame makes a correspondingly smaller angle with the horizontal.

The bow collectors are kept in contact with the overhead conductors by means of a compressed air piston, which piston acts upon a controlling spring so as to raise or lower the collector. If the locomotive has been standing (no compressed air being available) the air cylinder can be worked by means of a small air pump, thus raising the collectors and making contact with the line; as soon as this takes place the motor compressors at once start.

All the high-pressure switch gear and apparatus is enclosed in a sheet-metal case, the opening of which can only be effected when the bow collectors are not in contact with the overhead line.

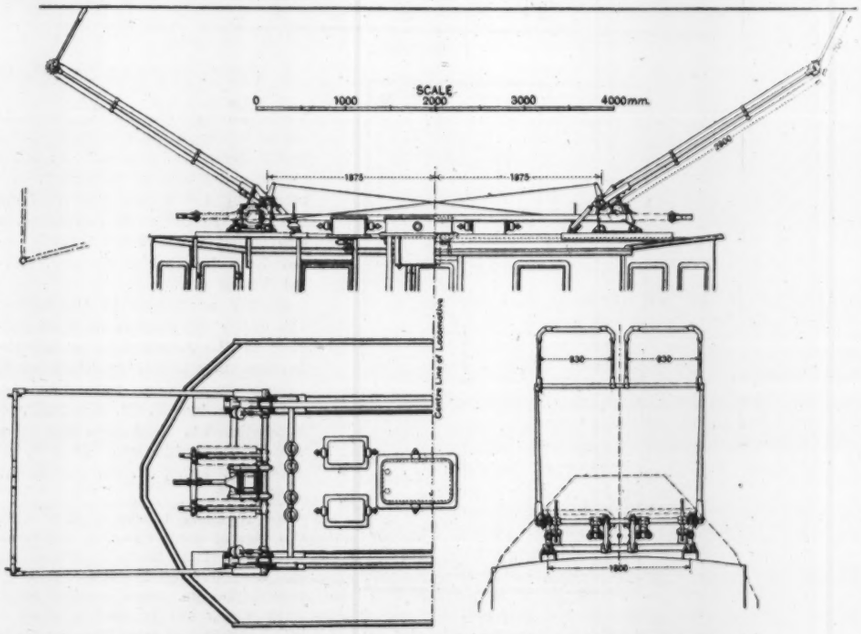


FIG. 2. ARRANGEMENT OF THE CURRENT COLLECTORS ON THE LOCOMOTIVE.

FIRE TEST OF A CINDER CONCRETE FLOOR.

A cinder concrete floor constructed at the Columbia Fire Testing Station on 116th st., one block west of Broadway, New York City, was given a fire test on Nov. 20 by Prof. Ira H. Woolson under the supervision of the Bureau of Buildings.

The floor was built in two sections across the top of an inclosed fireproof structure. One section was built between a 4-ft. 6-in. span, and the other section between a 5-ft. 6-in. span. The concrete in the smaller span was reinforced at intervals of 12 ins. by No. 16 2-in. hoop-iron bent

*Abstracted from "The Electrician" of London.
†Engineering News, March 2, 1905, p. 229.

*See also Engineering News, May 4, 1905; p. 461. The two electric locomotives now doing service in the Simplon Tunnel were originally intended for the Valtellina Railway. Two additional locomotives for the Tunnel are now being built at Messrs. Brown-Boveri's Baden Works.

S-shape and supported between the side girders. In the larger span the S-irons were placed at 9-in. centers. The concrete used in both sections was a mixture of 1 part sand and 6 parts cinders, and was applied to a thickness of 5 ins., this covering the S-irons 1¼ ins. top and bottom. The floor was loaded 150 lbs. per sq. ft. for the fire test.

The fire within the enclosed structure was brought up to over 2,000°F., an average of 1,700°F. being maintained throughout the 4 hrs.' test. The maximum total deflection of the floor during this time was 2 7-16 ins.; this, however, diminished to 15-16 in. after the floor became thoroughly cool. As the permanent deflection, according to the Bureau of Buildings, must be less than 2½ ins., this requirement was passed satisfactorily. The floor also allowed no smoke or light to pass through it, and no cracks were visible upon the application of water 4 hrs. after the fire was started.

On Nov. 21, the day after the fire test, the floor as previously constructed and tested was subjected to a load of 600 lbs. per sq. ft. The deflection which resulted was 1⅛ ins., or well under the requirements of the Bureau of Buildings. Sprickerhoff & Scharnberger, 1924-1930 First av, New York City, built the cinder concrete floor tested.

THE WORK OF THE ENGINEER.*

We have been told—and we are all very ready to believe good of ourselves—that the engineer is the most powerful instrument of civilization and progress which exists, because without him there would be no railways, no steamers, no telegraphs or telephones, no electric power to be distributed free to everybody, no motors, and hardly even the roads for motors to run on, with which latter, by the way, engineers have scarcely yet been able to furnish us. It all sounds very obvious, and we may each congratulate the other for his share in the stupendous engineering progress of the last half-century. It is always pleasant to feel ourselves very superior persons, and still more pleasant to be convinced that in earning our daily bread we have been also conferring high moral benefits on our fellow men.

I do not want to cool down the glow of satisfaction induced by the consideration of these views of existence, when enlarged upon by the more eloquent members of our profession. Possibly such ideas may even help some of us to do our work better, and, if so, they are of real benefit. But, if so, it can only be in the same fashion as that in which a foolish, or an unwise, or even a wholly misguided enthusiasm has sometimes led armies to victory; and it may be as well to take a more reasonable view of the relations between engineering and modern civilization.

The glorification of our profession, of which I have been speaking, while, as I have said, possibly useful to encourage us and keep us up to the mark, is, after all, surely due to reasoning in a circle. If we merely say that progress in engineering matters has been due to engineers, we say what is true, and what is at the same time practically the whole truth. But we have no right to assume that if there had been no railways and no telephones, no electric light and no motor omnibuses, the world would have been a whit less civilized, less moral, or less happy than it is. It would only have developed along other lines than the present mechanical ones. While engineers also are so ready to take credit for what they have done, they have to remember that they must also take their share of responsibility for it. It is quite easy to conceive of a civilization developed on unmechanical lines, under which our people might have been more thoughtful, better read (in everything except newspapers), less prone to absurd excitements about what we call "politics," less ready to join in united shouting about things they do not understand, less easily persuaded to bring the State even to the very brink of war with good friends and neighbors at the bidding of some "yellow" journalist, whose malicious ravings would never have had any circulation if we engineers had not provided the printing machinery and the special trains.

It is never safe to talk of "might-have-beens," but it is clear that it is mere begging of the question to assume that everything that has come about has been for the greatest good of humanity, that all the inevitable movement and change which goes on is towards improvement, or that the much misused word "progress" should always connote improvement at all. Do not many of us know in our hearts, at the end of a busy and worrying session—and all sessions appear to be busy and worrying—that we would contentedly sacrifice half our work, and more than half our incomes, if we could only live quietly and peaceably, have some breathing time to think and to see and to read, be a hundred miles from the nearest railway station, receive letters once a week, and know that telegrams cost a shilling a word.

This is by way of making it clear that I am not going to start on any discussion of the engineer with the assumption that he is the salt of the earth. But I do start from the position that, as his predecessors were responsible for starting the world on 100-lb. rails when it refused any longer to jog contentedly along on macadam, he himself must now do all he can to see that the lines laid and being laid are leading in the right directions, and not assume complacently that all roads lead to perfection simply because he has put them down. However, the world intends to go by machinery for our time, at any rate, and we engineers are the drivers and the signalmen at the same time. I hope we may be able to do our work with a full sense of the serious responsibility of this double position. Can we cultivate such an ideal that our widely-extended influence shall really be for the benefit of the community, not only in giving them good railway service and cheap power, but in some wider and much more important fashion?

In relation to science, I have always claimed for engineers a very high place, a place much higher than some of my purely scientific friends are disposed to allow them. I really believe not a few engineers have spent their whole lives in scientific work while they were nominally only earning their daily bread in ordinary mechanical pursuits. Engineering problems differ from ordinary academically "scientific" problems, partly in that they are much more complex, and consequently more difficult of anything like exact solution, and still more because—exact or inexact—some solution to them has always got to be found. Not only must the solution be found, but it has to be translated into steel and gun-metal, as well as into £ s. d., and any mistake will entail very much more serious consequences than a controversial paper in the "Philosophical Magazine" or a letter in "Nature" pointing out a wrong estimate of terrestial radioactivity in prehistoric epochs.

But a word of caution—unnecessary to the experienced, but sometimes necessary nearer the start. The mere use of formulas or of exact calculations of any sort is not in itself scientific. That man shows far more of the scientific spirit who recognizes when his data do not allow of the use of any exact formulas, and who therefore reasons with what may be called mathematical commonsense, than the man who tries to force the facts to fit a class-room formula, and arrives at a result which satisfies the formula without recognizing that it bears no relation to the facts. The scientific engineer may use elaborate calculations or he may not; a most important part of his science lies in judging whether to use them or not. Conversely, the man who calculates elaborately may be working scientifically or he may not. The mere calculation is not scientific, and in certain cases may only be a cloak to essential defects both in scientific method and in technical perception.

Perhaps, in the early stages of human or of mental development, it is desirable that the mind should be nurtured on dogma—fixed, certain, and infallible—and, if so, the scientific dogma is probably the least poisonous variety of the species. But whatever may be the case at first, most men who have devoted their lives to science have come eventually to hold their original dogmas very loosely, and to recognize that they are, after all, only semi-crystallized versions of very imperfect knowledge. And the engineer, of all men, should have the earliest opportunity of working himself free from the youthful leading-strings. From the day that his pupilage ends until the last day of his engineering life he is always face to face with the fact that there are half-a-dozen ways of doing everything, and that the half-dozen ways are more or less equally good. I suppose most of us carried our boyish cocksureness right through our pupilage, and left our first shops or offices with a notion that everything ought to be done exactly as it was done there. But the notion was dispelled with an almost overwhelming shock when we found out that elsewhere no one cared in the least what our people had been doing, but got the same results by quite different methods. The more we see of engineering work the better we know that none of our problems has one single solution, that all of them can be worked out to the same end in many different ways, and that it is very seldom indeed that, except as to some small detail, any one method is so much better than the others that it has any special claim to be called the right method. If this is the experience of our everyday life as engineers, and in relation to the things about which we know most and to which we have given a lifelong study, ought not we engineers to be able to set the world at large an example of tolerance and broad-mindedness in other matters and as citizens, which would not be easily reached by any other class of the community?

To what extent do engineer and artist come in contact? It can hardly be denied that there are points which at least ought to be points of contact in their work, although their paths seem frequently to intersect rather than to be tangential, and the intersection is too often at 90 deg.!

As regards machinery of every kind, from marine engines to sewing machines, we have come to recognize that at present our business is to use the material in the place where it is wanted, and of the form best adapted for the work which it has to do. Between moving machinery and architectural structures there is no analogy; and to apply to the one the classical rules or conventions of the other, as was once attempted to a certain extent, is surely a mistake in art as well as in engineering, and the eye has now recognized this. But it would imply, I think, a very narrow range of perception of things beautiful to deny a beauty of a genuine kind—although neither classic nor romantic—to an express locomotive, or to a great marine engine as it stands in the erecting shop. We used to compare the hard outline of the steamship, with its clumsy funnel and abortive masts, with the graceful lines of the three-master and the beautiful forms and color of her sails. But even already, although steamships are things as yet of our own generation, now that they have cut themselves adrift from all suggestion of imitation of their predecessors, everyone recognizes that there is a dignity in a "Dreadnought" which is almost majestic; and that the modern liner, properly handled, forms really as fine a subject for a picture as a full-rigged ship, although naturally the pictures are different.

But with engineering structures the case is different, and certainly the question is more difficult. We have to build—or to get built for us—bridges, viaducts, dams, stations, power-houses, goods-sheds, factories, and so on. All of them come into direct comparison with the ordinary structures designed by the architect and seen and judged by the public at large. Often, unfortunately and unreasonably, they are compared, not with the ordinary structures, but with the noblest of architectural buildings, and we are asked to compare, say, York Railway Station with York Minster, which is obviously unfair.

Perhaps our greatest difficulty in this matter is with our steel bridges. They are unavoidably so much in evidence that even "the man in the street" considers himself fully competent to form, and therefore to express, an opinion about them. I need not say that "the man in the street" is really able to do nothing of the kind, except, of course, to express an opinion. None the less it behooves us to take care what we are doing, not for the sake of the mere surface opinion of to-day, but in order that, by the time our work has become ancient, it may also be considered worthy of the respect due to age, and not the mere survival of an early-Victorian period in the youth of engineering. Our first consideration should be—of course, after considerations as to strength and engineering suitability—that the form of the structure should be determined essentially by the material of which it is made, and not based upon the forms of older structures, however beautiful in themselves, built of quite different materials. The carved mouldings and details which lend so much beauty to a structure of stone, are apt to impress us only as "cheap and nasty" when reproduced in cast iron. Similarly, the curves and scrolls of a Gothic pattern, if imitated in malleable iron on a structural scale, do not give the idea of beauty, but merely of material used in a wrong way. It would be impossible here, even if I had myself the necessary artistic knowledge, to discuss the question of how the lines of a structure—and our structures are all lines together—affect our sense of its proportions. But examples of structures which, although doubtless economically designed, are undoubtedly hideous, will occur to many. On the other hand, such structures as the Forth Bridge here, or Roebling's Suspension Bridge in New York—many others might be named—are examples of what can be done to please the eye, while at the same time utilizing the material with every possible economy, and satisfying all the demands of scientific fitness.

At the risk, however, of being considered a Philistine, I feel bound to say that I do not consider a well-designed lattice-girder—such, for example, as those of the Charing Cross Bridge—to be in itself ugly. I make bold to say that after another forty or fifty years, if the bridge is still in its place, it will be recognized that a straight line is not in itself hideous—which seems to have been recognized long ago in Athens. And if it be once admitted in principle that a girder bridge, in spite of being straight, may be looked at without pious horror, the critics may cease to affect displeasure, and even come to regard such structures as simple and straightforward, and in their whole effect not at all unpleasing.

About engineering buildings the same class of questions does not arise. They must just take their place with any other buildings. If they are for purely industrial purposes, their form, and even their external appearance, must inevitably be mainly determined by their purpose. But even here we are most of us familiar with the extraordinary difference which a little artistic feeling can make by very small changes and at small expense, and I hope that in future we may not be so great sinners as in the past in this respect.

We expect architects to consult and employ engineers to help them over structural difficulties, and we may

*Condensed from the Presidential Address of Sir Alexander B. W. Kennedy, LL. D., F. R. S., before the Institution of Civil Engineers.

even scoff when they come to grief for not doing so. They are, on the other hand, quite entitled to turn the tables on us when they see that an engineer has put up a hideous barn which they could have transformed into a pleasing structure by their own special knowledge, and by that sense of form which it has been their chief business to cultivate, while we have been working at bending moments and breaking loads.

With another profession, that of the law, we are brought by our daily work into very close connection, so close that in many matters it is necessary for the engineer to carry out his work in the most strictly legal spirit, however undesirable it would be for him to be "his own lawyer." All engineering work of importance is carried out according to both a specification and a contract. An engineer prepares the specification and is practically responsible for the contract, while very often other engineers—from the manufacturing side—accept both documents and undertake to work to them. There is little doubt that the more strictly legal, which means in this case equitable, the conduct of both parties is, in reference to these documents, the less is the probability that the aid of the purely professional lawyer will have to be called in later on.

On the manufacturers' side there is one chief and simple, but absolutely necessary, duty to perform in reference to these documents—namely, to read them. The duty is as simple and as obvious as "keeping your eye on the ball" in another phase of existence, and is just as often neglected. Hence many tears. If the contractor or manufacturer is dealing with a responsible and experienced engineer, he may be sure that the documents are intended to mean what they say, and that—barring mistakes—they do mean it. If, therefore, he finds that he cannot do what he is asked to do, there is nothing to be gained by slurring it over. The only means of avoiding trouble is the raising of all doubtful points before the work begins, so as to get them settled. If, on the other hand, the contractor is dealing with an irresponsible or inexperienced engineer, and no doubt there are such, it is all the more necessary that he should know exactly what he is asked to do. For in that case there may be meanings in the documents which only careful reading will discover, but which will certainly be taken advantage of, later on, against the contractor himself.

On the side of the engineer who draws up the specification, it is surely his duty, after drawing it up, after stating as clearly as possible his requirements, to endeavor to go through it from the point of view of the contractor, and make sure that there can be no reasonable doubt of the meaning of the words or phrases he has employed. This is every bit as true of the specification as of the contract; but whereas with the latter there is always legal help available, with the former the engineer has to trust to his own power of exact expression in saying just what he wants, and no more and no less than he intends to have.

The question of how much or how little to put in a specification is one about which no very general rule can be laid down. Naturally, much depends on the engineer, on the contractor or manufacturer, and on the nature of the work. But first and particularly it is the duty of the engineer to define exactly what results he wishes to obtain. If he is unable to say what he wants he can hardly be the right man for the work, and had better leave it alone. He can also say, quite exactly, the nature of the materials he requires to be used. In the majority of cases he can also say in what way the work is to be carried out, what machinery or apparatus or appliances are to be used, and how they are to be arranged or applied. Or, if there are several ways in which his requirements can be met, he can indicate one of them and leave the contractor to suggest others. No doubt cases arise in which the requirements are such as can be fully met by certain methods or appliances only of a certain particular manufacturer or contractor, but in general a specification cannot be too full—it can certainly never be too clear—in dealing with general requirements and results. But in details it may very easily be too full, and no greater mistake can be made—nor any mistake more likely to lead to vexatious litigation later on—than to crowd up a specification with detailed particulars as to matters which every competent contractor or manufacturer can carry out equally well in his own way. I would therefore put, as the characteristics of a good specification, definiteness and clearness always, fulness as to requirements and as to guarantees, freedom and openness as to those details and methods which are largely matters where contractors have had very varying experiences.

Personally I have very strong views as to the inadvisability of making an engineer the arbitrator in relation to his own specification, although I know that some public bodies have different ideas. But even where the engineer is not the final arbitrator, there are sure to be many points of detail in relation to the carrying out of the work according to the specification which he solely will have to settle. And in these it is very desirable that his attitude should be, as far as possible, that of an arbitrator rather than of a party to a dispute. It is really here that the special importance of definiteness and clearness in the original wording of his specification comes in. If he has said exactly what he wanted in terms which could not reasonably be misunderstood—if they had been reasonably and carefully read to start with—he can make his decision as fairly as if he were an arbitrator. But if his specification has not been clear, or has been insufficient to start with, his decision must necessarily be colored by his own unexpressed intentions, his own view of what he meant; so that, although honestly given, it may not be by any means certainly the decision which an arbitrator would have given under the same conditions. Strictness, or even what is called severity, in a specification is not in itself against the interest of the contractor. As long as he can see what is wanted it is his business to prepare for it. If the contractor presumes on the engineer being slack in construing his requirements, that is his fault, and he is rightly penalized when it turns out that he has caught a tartar. But a carelessly-worded specification, or one in which important requirements are slurred over or only indicated inferentially, is unfair to the contractor, is unworthy of the engineer, and is likely to lead both into trouble as well as to result in unsatisfactory work.

With ordinary commercial life, every engineer stands in very close touch—the manufacturer, of course, directly, the consultant indirectly, but hardly less intimately. We shall not go wrong, any of us, if we can only make up our minds that, as to our work—whether hand work or brain work, metal work or paper work—its quality is the first thing to be considered, and that, as to ourselves no amount of profit is worth having if it is obtained by us as mere money-getting machines, and not as gentlemen. We are rather fond of talking loosely of engineering as a "profession." I am not sure what authority is entitled to say whether engineering is or is not a profession. It must be a very young one certainly, if it is one at all. But by all means let us call it a profession, and then let us do our work accordingly. I fear it must be confessed that with some engineers things have occasionally not been thought unworthy or improper which, although not in themselves dishonest, would be impossible among lawyers or doctors, which ought to be impossible among gentlemen, and which would be impossible among ourselves if our organization were as complete and our etiquette as strict as in the older professions. I ask members of this Institution to keep before them, for their own sakes, as well as for the honor of the Institution, an ideal of business or professional conduct at least as high as exists in the older and recognized professions of law and medicine, even although honorable behavior cannot, among us, be enforced by legal penalties or disqualifications.

A more subtle difficulty connected with the business side of our engineering life arises in the relations between the two great sections of engineering, which one may call the contractorial and the consultant. Each branch is honorable in itself—neither more than the other; many excellent engineers also have changed from one to the other for their own advantage, and to the advantage of engineering also. But now and then an attempt is made by honorable men, and in all honesty, to be contractors and consultants at the same time. Every such attempt, so far as I know, has ended in failure, and I am sure that the combination is to be deprecated. It may be a counsel of perfection, but I would go so far as to say that a consultant ought not even to hold shares in any manufacturing company with which there is the slightest chance that he may have to do in his professional capacity. There are plenty of things in which we can invest money without being in the least hampered by a self-denying ordinance of this extent.

It goes without saying that the relationship of engineering work to the industrial life of the country is of vast importance. Directly engineers are very large employers of labor; indirectly, through our railways and manufactures, we must be responsible for the employment of more "labor"—using the word in the popular sense—than any other set of men. Would it not be possible to take advantage of the present time, when the relations between employers and employed are, taken over the whole country, friendly and cordial, and when business generally is becoming more prosperous, to follow up the good beginnings which have already been made, and to take still more extended steps towards the establishment of joint trade committees, appointed specially to act when required as arbitration tribunals, under experienced leaders whose names would command universal confidence? Hitherto we have too often tried arbitration only when a fight was imminent, and when feelings were already strong on both sides, when each side had made up its mind vigorously, and when for either to give way meant some injury to *amour propre*. Surely that is a wrong way altogether. We know perfectly well that disputes will arise, and we know just as well that only in very exceptional cases is either of the two sides likely to be entirely right. At present the two sides say "can't" and "must" to each other [illegible] they are out of breath, and angry. How much [illegible] if machinery existed which had been created by both parties together, in which both had reason to trust, [illegible] could take up and settle the difficulties before the [illegible] of mutual recrimination and vituperation had even [illegible] menced. There are times when the employers must [illegible] up with diminished profits—they have no divine [illegible] that everything should remain as it has been when [illegible] has been most satisfactory to them; there are [illegible] when the employed must put up with reduced [illegible] they have no divine right to a permanent continuance of the wages they have earned when trade was at its very busiest.

What of the future of engineering? Is it possible to predict, or even to indicate with any approach to certainty, the lines on which the engineering work of our grandsons is likely to be carried out? I fear that it is not possible.

To a certain limited extent a traceable process of evolution does apply to both machinery and structures, with the latter only to a very limited extent indeed. It cannot be said, I suppose, that we can to-day make finer masonry structures—structures more perfect either from an artistic or a scientific point of view—than the Romans could, or the Greeks before them, or the Egyptians long before either. The only great developments in structural work have come about through the use of new materials and new methods for handling them. Concrete on the one hand—which in its present form may be considered new—and steel on the other hand, especially, have entirely altered our structural methods. As a species, steel structures may certainly be said to represent a "separate creation." The years taken to develop iron and steel-making machinery, and to develop the methods for using the material, are so few, historically, as to represent only an instant in terrestial time. And before them the centuries went on one after another without bringing about the least indication of what was to happen in the fulness of time.

With machinery the same thing occurs, even in more marked fashion; one "species" after another starts suddenly into being, sometimes through the inventive talent of a single man, perhaps more often through the joint endeavors of many minds, directed to one special point by some requirement of practical industrial life. No doubt it might be suggested that the reaction wheel of Hero was a great grandfather of the present steam turbine; and I dare say it may be possible by diligent search to find—at least on paper—a somewhat discontinuous series of actual or possible machines connecting the one with the other over the interval of a couple of thousand years. But so little is there any real connection between them that up to a few years ago Hero's machine was always given in historical text-books simply as a steam engine, and as the precursor of the present steam engine pure and simple, with no reference whatever to the special peculiarity—in fact, in spite of that peculiarity—that it was a turbine. Although no doubt the steam-turbine of to-day is a development of and improvement on the steam-turbine of twenty years ago, yet practically all this development and improvement has occurred at once, instantaneously, while nothing whatever occurred between B. C. 200 and about 1890. The steam-turbine, in fact, was a new species, a "separate creation," and, as such, nothing connected with it or its possibilities could have been predicted on evolutionary lines beforehand.

It would appear as if "invention," whether in the popular acceptation of the word, or in the sense of painstaking working out directed to an object of immediate importance, constitutes such a disturbing influence in mechanical or engineering evolution that it is useless to attempt prophecy on evolutionary lines. It is, I am afraid, still more useless to try to forestall the future by trying to do to-day what one thinks may possibly be done by others ten or twenty years hence. Such attempts have been made several times, and much as we may admire the spirit of the attempt, we cannot, judging by results, admire its wisdom. The building of the "Great Eastern," whose history is a pathetic tragedy in engineering, which had to be broken up for scrap almost in sight of the "Carmania" and "Caronia," is a case in point which will occur to everyone.

But here again, unfortunately, "artificial selection" sometimes comes in, and plays havoc with the "laws." For although it may be pretty safely said that no invention becomes a great success that is not sound and useful essentially, it must also be admitted that every now and then an invention of distant utility disappears altogether—failing either through want of money or push on the part of its friends, or by too much money and push on the part of its rivals.

Another direction of developement, especially in connection with mechanical affairs, is no doubt the increase of directness, the avoidance of transformation, and the decrease in the number of separate stages by which a required result is obtained. We burn coal, pass a part of the heat of combustion to water through metal which absorbs some of it, and utilize the balance for evapora-

tion. We use a portion of the energy so gained by the steam in doing mechanical work, and a portion of this portion is transformed into electrical energy. But electrical energy as such is required for very few purposes, so that in general some percentage of the electrical energy is again turned into mechanical work, and even of that only a small part is actually useful—or it is turned into heat, of which a still smaller fraction appears as light and is used as such. I read a paper on this subject before the Royal Institution some thirteen years ago, in which I pointed out that in the case of electric light much less than one per cent. of the whole heat of combustion with which the process started appeared actually as the useful and salable commodity—light—at the end. Electric lamps are more economical now, but the proportion still remains ludicrously small.

It would seem natural to hope, therefore, in looking forward, that one of the chief directions in which the engineers of the future will carry out successful work will be that of increasing directness, avoiding transformation, and greatly increasing the efficiency of whatever transformation remains necessary. Engineers hardly need the warning, but the public certainly does, that so-called "improvements" in this direction, made without knowledge of what existing efficiencies are, or which embody physical impossibilities as soon as they are reduced to figures, are not schemes in which to invest money or promising real engineering development, to say nothing of commercial success.

A NEW STYLE OF REFRIGERATOR CAR DOOR.

A refrigerator car door of new design has been thoroughly tested in service, with satisfactory results, by the Central Railroad of New Jersey. Fig. 1 shows a car fitted with this door, which has been in continuous use for over three years without any repairs being made upon it. As will be seen, the door is a flush type sliding door, which does away with all danger of the door becoming unfastened and swinging out, thereby fouling passing trains. Also, the door can be opened at any platform without striking it.

Fig. 2 shows plainly the mechanism and the manner in which the door operates. As shown, a system of levers (a, b, c) is connected by a link (d) to a rocker shaft (e), which is provided with two rocker arms (f). These arms support the door when open and keep it pressed to its seat when closed. The rocker shaft (e) is supported by two hangers (g), which slide on a steel track when opening or closing the door. When the door is closed the bottom is prevented from swinging outward by two lugs, one on either jamb of the door, which engage steel bars fastened to the door. The lugs are beveled so that as the door is forced into place it is tightly seated. A chain fastened to the door and a slide rod under the car prevents the door swinging outward when open. To allow for shrinkage and expansion of the wood sheathing, the edges of the door are provided with galvanized-iron joints (shown in section in Fig. 2), so that the door never sticks or is loose, yet always gives a tight joint. To overcome the friction of the eccentric hanging of the door as to the track when open, the hangers used are side-bearing, while the track is very wide. This arrangement makes the door slide very easily. All connections of levers, etc., are made with cotter and cotter pins, thereby making it practically impossible for the mechanism to jar loose.

The manner of operating the door is as follows: Disengage lever (a) from rack (h) and force to position shown by dotted lines. This operation rotates by means of the link motion the rocker shaft (e), which raises, through the rocker arms, the door into the position shown by the dotted lines of end elevation, Fig 2. The door is then slid to one side, the same as any sliding door. As the lever (a) is operated the rocker arms throw the top of the door outward and upward, the upward movement disengaging the lugs and bars at the bottom of the door, which permits it to swing outward. To close the door it is only necessary to push the bottom in and drop lever (a) into its original position, enough force being exerted on the lever to force the door tightly into place.

The advantages claimed for this door are: (1) Ease and speed in opening and closing; (2) as cheap, first cost, as the present swing doors; (3) minimum maintenance expense; (4) absolutely tight joints; (5) not possible to become unfastened and interfere with passing trains; (6) the only one-piece refrigerator car door in use; (7) it can be opened at any platform.

This door is the invention of Mr. Sinclair J. Johnson, 10 Wall St., New York City, and is protected by United States patents. Mr. Johnson is also the inventor of a flush door for ordinary freight cars, which operates in a manner similar to the refrigerator car door here described.

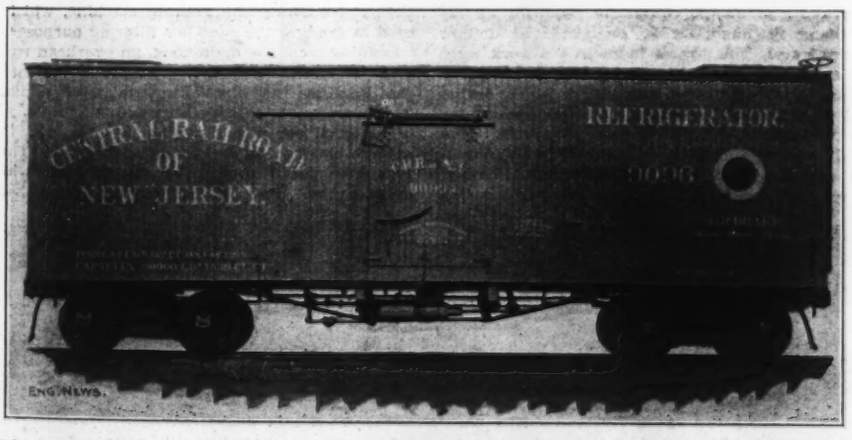
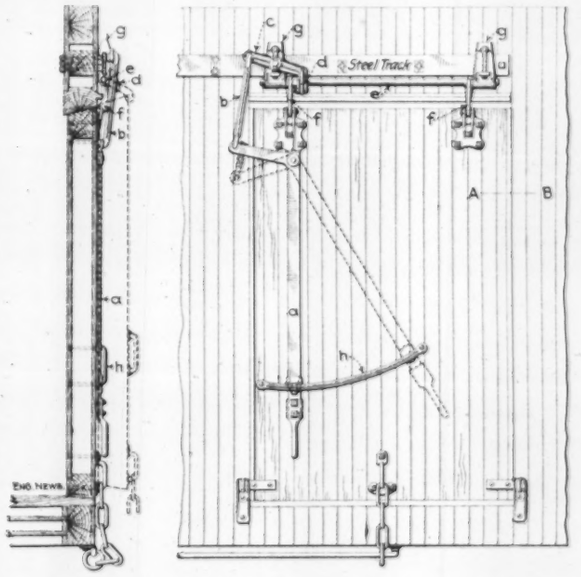
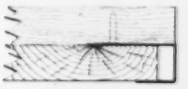


FIG. 1. A REFRIGERATOR CAR FITTED WITH THE JOHNSON FLUSH DOOR AND OPERATING MECHANISM.





Enlarged Section A-B, Showing Arrangement of Galvanized Iron Joints.

FIG. 2. VIEW SHOWING THE ARRANGEMENT OF THE JOHNSON FLUSH DOOR, AND MECHANISM FOR REFRIGERATING CARS.

TURNING DRIVING WHEEL TIRES: CANADIAN PACIFIC RY.

In our issue of Sept. 13, we published a description of a large lathe for turning driving-wheel tires, and the forms of tools of high-speed steel used in this machine. One of these machines is in use at the Angus shops of the Canadian Pacific Ry., at Montreal, and we have recently received from the superintendent of these shops some interesting particulars of the work done on these lathes. We quote from his letter as follows:

We use the Krupp crucible steel tires and in ordering them we state if for passenger, freight or switching service. The manufacturers make good any defect or breakage that comes up during the life of the tire, except in case of breakage when the tire is not of a fair service thickness. The defects or breakages that develop from the Krupp tire are very, very few, and happen mostly during the winter months, which are very severe along our lines.

The Krupp tire, while hard, is not brittle, but a very tough tire, and keeps its shape right down to its minimum limit of wear or until it is ready for scrap. In turning these tires with a heavy cut and feed, there is no more evidence of injury to the tires than there is in turning softer tires; in fact, I think that with the present rigid support of wheels or tires in the lathe, and with good high-speed steel tools, there is less injury in turning tires than in older times, with the lighter cuts and slower feeds, for now we do the turning with tools that cut smooth and clean. After we run a roughing cut we scrape our tires to shape with forming tools, and I doubt if any other road makes a better and smoother finish. Some roads do not take time to put on this good finish, and, of course, that helps to make a larger output, but output should be considered not only in quantity, but also in quality of work.

We find it impossible when turning Krupp tires to run at as high a speed as is done at shops on some American roads, for the simple reason that the tools will not stand, and, of course, as soon as a tool gets dull it pushes away from the tire. Our wheel-lathe man would much prefer turning an 84-in. American tire than a 57-in. Krupp tire, and he will run the same speed of the face plate with the same feed and depth of cut for both tires. In fact, the tools seem to show they could stand a little more speed on the 84-in. tire, while on the 57-in. it is up to its limit. We have had some disappointed tool steel men here and quite often we have found that high-speed steel which made a very good record in turning tires in shops on some American roads, cannot stand on our work simply because it is put against a very tough material. We cut the metal off the Krupp tires just as clean and smooth as from softer tires, but what suffers is the tools.

AN IMMENSE BED OF IRON ORE has been discovered near Port Arthur, Ont., according to press reports. This hematite deposit lies about 20 miles east of Port Arthur and covers an area averaging about three miles in width and six miles in length. The deposit reaches to within 1,000 ft. of the shore of Thunder Bay, Lake Superior, and is estimated to contain at least 200,000,000 tons of high-grade ore. Tests have shown that the deposit ranges in thickness from 8 to 35 ft., and it is said that it is the only large body of high-grade Bessemer hematite in Canada. The deposit lies in sheet formations, much of it without covering, and all of it can be quarried without underground work being done. The ore is said to run as high as 70% in metallic iron, with little phosphorus or sulphur, and only 1% of moisture.

CONTRACTORS' PLANT AND METHODS ON THE CONSTRUCTION OF THE PITTSBURG FILTRATION PLANT.

By Robert Swan.*

The Pittsburg filtration plant, now nearing completion at Aspinwall, Pa., a few miles east of the city for which the plant is intended to supply filtered water, is one of the largest pieces of public work now under construction in the country. The entire filtration plant will cover an area of about 125 acres. There will be 46 covered filters, constructed of concrete throughout, each filter covering an acre of ground and having a daily filtering capacity of 3,000,000 gallons.

There will be two large sedimentation basins and one receiving basin. These three basins cover a total area of 27 acres, in which the raw water will be permitted to settle before passing into the filter beds. The capacity of each of the sedimentation basins will be 65,000,000 gallons, and that of the third or receiving basin will be 20,000,000 gallons. The capacity of the pumps which will supply the filters with raw water from the Allegheny river, will be upwards of 150,000,000 gallons per day, with a possible overload of quite an additional percentage.

*Vice-President and General Manager, the T. A. Gillespie Co., Westinghouse Building, Pittsburg, Pa.

The filtered water reservoir, where the water will be temporarily stored after passing through the filters and before entering the pipes crossing the river, has a height of 26½ ft., covers five to six acres, and has a capacity of about 45,000,000 gallons. This basin has also a concrete roof.

The two steel pipes carrying the filtered water under the Allegheny river to the Brilliant pumping station, on the Pittsburg side of the river, where the filtered water is forced to the city, are each 72 inches in diameter. These pipes are laid in an open trench in the bed of the river by means of cofferdam construction, the processes of which will be touched upon later.

The contract for this entire work was let, at one time, to the T. A. Gillespie Co., of New York and Pittsburg. To complete this enormous plant in the short time of 2½ years allowed by the contract required a working force of upwards of 2,000 men and a plant and equipment requiring an investment of hundreds of thousands of dollars at the start. The largest items in the work were the excavation and concrete, it being necessary to excavate for all basins, reservoirs, filters, drains and pipe lines, as well as for the foundations for the various buildings and gate chambers. The total amount of excavation required to be done in the course of the work will be, approximately, 850,000 cu. yds. The filters, reservoirs and basins being of concrete construction throughout has made necessary the installation of the largest concrete-mixing plant in the world.

For the work of excavation, the contractors have used four steam shovels, with a combined capacity of 4,000 cu. yds., and two elevating graders, with a combined capacity of 2,000 cu. yds., making the total excavation possible per day with these machines alone, 6,000 cu. yds. Besides these over one hundred teams and a small army of men with dump wagons and wheeled scrapers have been at work. Aside from the many teams employed in handling the material excavated by the steam shovels and graders, there are twelve dinkey locomotives employed on the work for this purpose also. All the capacities named above are, of course, for a day's work, and by working overtime the output can be greatly increased, and this has been done during the summer months.

In the construction of the concrete work, an even larger and more complex plant was necessary than was required for the excavation. In the first place, the sand and gravel had to be obtained and there had to be a dry place for the storage of the cement. Accordingly, two great storage houses for cement have been erected, having a combined capacity of 25,000 barrels, and during the working season these storehouses are kept constantly filled.

The sand and gravel for use in the filters is dug from the bed of the Allegheny river, for which purpose a number of sand and gravel bucket dredges are being used. The sand and gravel is transported from the dredges to the main dock in flat boats, and at the main dock these boats are unloaded by two clam-shell derricks, the material being deposited in large storage bins. These two derricks will unload and place in the bins 1,200 cu. yds. of material per day.

Aside from the main dock, which supplies that portion of the work where the filters are being constructed, there are two other docks, known as the upper and lower dock, the former having a daily capacity of 600 cu. yds. of material, and the latter having a capacity of 1,200 cu. yds.

The main dock is equipped with a battery of boilers, the hoisting engines and clam-shell derricks required for unloading the sand and gravel, large storage bins for the material, the engines for driving the tramway mentioned below, and is fully equipped to handle easily and speedily all of the materials required to keep the work going steadily. Underneath the dock there are tracks for the dinkey locomotives and arrangements for loading the trains with sand and gravel from the storage bins above. The contractors' pumping plant is also located at this point. Here also is the sand-washing and grading machine, which is used in grading the sand for filtering purposes.

Leading from the main dock, an overhead tramway transports the sand, gravel and cement to the bins at the main concrete mixing plant. This tramway is capable of handling 1,800 cu. yds. of material per day, dumping this material into storage bins having a capacity of 2,500 yds. These bins are placed over a tunnel, through which operate two lines of endless conveying belts.

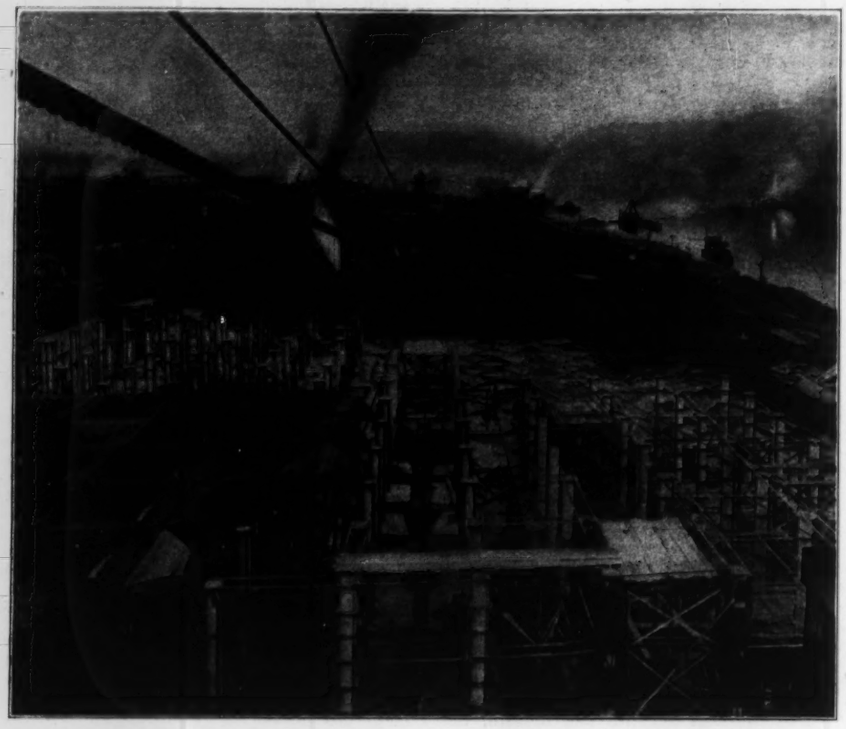


FIG. 1. VIEW OF FILTERED WATER RESERVOIR UNDER CONSTRUCTION.
(View taken Nov. 14, 1905, from top of cableway tower. In foreground, roof groin forms are in place, ready for concreting.

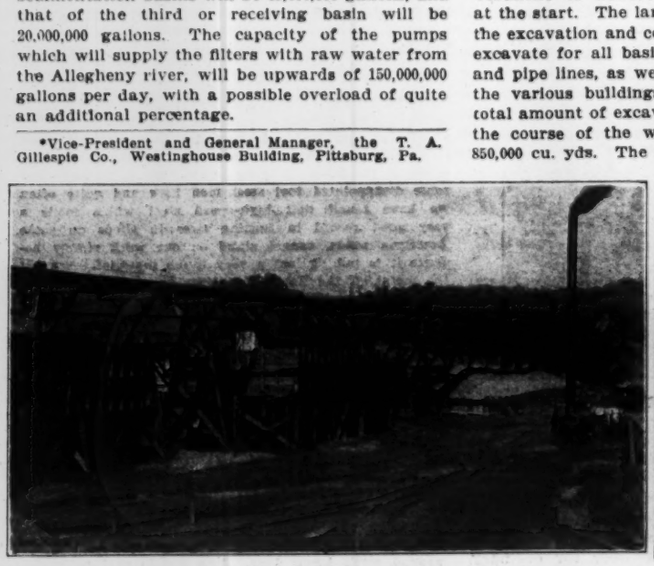


FIG. 2. CABLEWAYS IN USE ON FILTER-BED CONSTRUCTION.
(Alternate square panels of filter bed floor in place.)

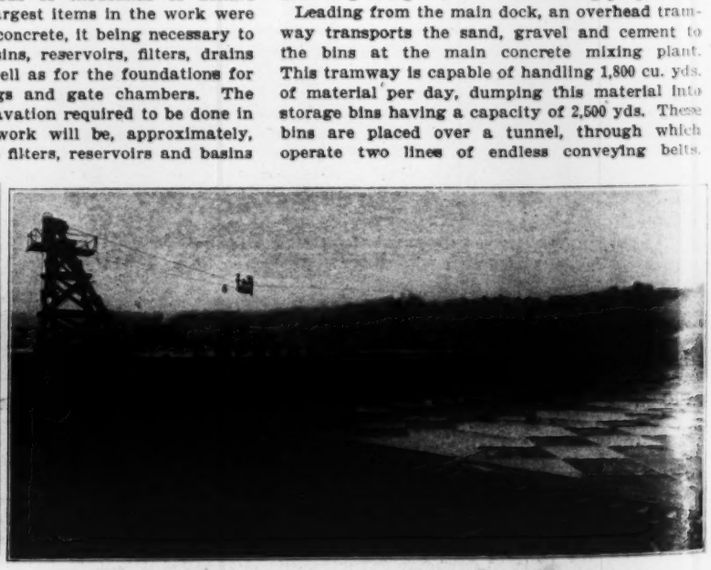


FIG. 4. GRAVEL SCREEN AND STORAGE BINS FOR GRAVEL AND SAND. BELT CONVEYORS TO CENTRAL MIXERS AT THE RIGHT.

The horizontal belts receive the materials through hoppers placed in the bottom of the bins, and in turn deposit the sand and gravel upon two inclined belts. These inclined belts carry the material to the top of the mixer, where it is fed by gravity through the concrete mixer.

The upper dock, located east of the main dock, near the river bank, has a full equipment also for handling the necessary material easily and expeditiously, and supplies the sand and gravel in an amount sufficient to keep the work going on the sedimentation and receiving basins, the floors and sides of which are being constructed entirely of concrete. The material is transported from the river front back to the location of the basins, by means of a narrow-gage cable railroad, running through the subway, under the Western Pennsylvania R. R. tracks, and the highway. The third, or lower dock, is located to the west of the main dock and supplies the materials required for the concrete work on the large filtered water reservoir and foundation for pumping station and the concrete intake conduit from the river as well as furnishing all the filling materials required, such as sand and gravel, for the river embankment and for the concrete blocks used for the revetment on the river front.

In the formation of these various embankments, it was required that the earth fill be rolled constantly, every 6-in. layer being compactly rolled before another layer could be placed. For this purpose a number of heavy road rollers have been in constant use, both on the reservoir embankments and on the river revetment. It is hoped by this means to make the banks so solid that there will be no possibility of any settlement, and in this way it is expected that the surface of the finished block paving will be preserved in perfect condition.

The main concrete mixing plant is composed primarily of two Hains gravity mixers. These will mix approximately 1,000 cu. yds. of concrete per day. Aside from this main plant there is one other Hains mixer constantly in use and two large Foote mixers, these latter supplying the work on the sedimentation and receiving basins, while the second Hains mixer supplies concrete for the work on the filtered water reservoir and river revetment. In addition to this, there are also four portable Foote concrete mixers, these being used for placing concrete in drains and conduits, and at other portions of the work not easily reached from the general plant. These four Foote mixers have a combined capacity of 400 cu. yds. per day, so that altogether the concrete plant installed and daily operated by the contractors is capable of turning out approximately 2,000 cu. yds. of concrete every ten hours of work.

For transporting the concrete from the mixers to the cableways, a railroad is used. This railroad is 1,000 ft. long, and was first operated by a traction rope, but later the cars were hauled by horses. Cars loaded with buckets of concrete are moved under the main cables and from there picked up and carried, quickly and easily by the cableway, to whatever portion of the work they may be required. There are four of these cableways in use constantly, when the weather permits, and each one will handle and place 300 cu. yds. of concrete per day. The towers of these cableways are from 50 to 60 ft. in height, depending upon the contour of the ground over which they operate, and they have spans ranging from 250 to 600 ft. In addition to the material thus placed, there is the concrete mixed and placed by the six Foote mixers, the materials placed in the sedimentation and receiving basins being transported from the mixers to the required location by means of dinkey locomotives.

These cableways, aside from the machinery which operates the various hauling, lowering and hoisting lines, are equipped with their own motive power and are altogether self-contained machines. Each tower operates along a track consisting of five rails and they move thus from one point to another as the concrete work progresses. Because of this method of placing the concrete, which is at once very speedy and economical, the construction of the filter beds has progressed very rapidly during the present season, and a large majority of the beds are either completed, so far as the concrete work is concerned, or very nearly so.

FIG. 3. TRAMWAY FOR CONVEYING CONCRETE MATERIALS TO CENTRAL MIXING PLANT.

The concrete for the sedimentation and receiving basins is transported from the mixers by dinkey locomotives, the tracks running into the reservoirs and traversing the bottom to every point, temporary tracks of light and durable construction being used, and so arranged that they can be easily transferred from point to point as the progress of the work requires.

Millions of feet of lumber have been used in the construction of the forms for use in placing this concrete, and in order properly to handle and dress this lumber and construct the forms, a large saw mill and carpenter shop has been installed. This mill is fully equipped with all the best and most efficient machinery for doing every sort of mill work, from the rough and heavy machinery to the finest of apparatus for small and particular work. In this mill and under the direction of the general foreman there are constantly employed a force of 125 to 140 carpenters. The construction of some of the forms—those for the odd-shaped conduits, for the connections between basins and drains, for the arches in the roofs of the filters and the filtered water reservoir, and for other difficult shapes—required not only the services of ordinary carpenters, but also men having a working knowledge of methods involving difficult computations as well as men skilled in the interpretation of plans of every sort. Some of the forms constructed exhibit very fine work.

As the construction of the concrete work of the filter bed is completed, it becomes necessary to install the overhead track system in the interior of the bed. This track system is being installed in each one of the 46 filter beds. It is proposed that this track shall carry the sand scraping and restoring machines, which are to be used in the working filter. From the illustration of the interior of a filter (Fig. 6) it will be seen that the lines of track run through the various bays and that there is no connection apparent from one parallel line to another. For the purpose of moving the machines from bay to bay, a transfer table is used, this table operating on a transfer track having a higher elevation than the other tracks and running at right angles to them. This transfer table is so constructed that the sand scraping and restoring machines may be run from the main tracks onto rails on the transfer table, carried by it to any other bay desired, and then run onto the main tracks in that bay again, the tracks on the transfer table accurately matching those in the various bays of the filter.

The scraping machines are so constructed that they will scrape off any desired thickness of sand from the top of the sand bed, leaving a perfectly level surface. The removal of the top of the sand becomes necessary, at certain times, after the filter has been in use, as there gradually collects on the top of the sand a jelly-like film, known as "Schmutzdecke," which finally becomes so dense as to prevent the passage of water through the filter, and so requires removal. The sand thus removed is carried through lines of hose out into the gallery, where it is put through a process of cleansing in the sand washers, and then is returned into the filter and replaced by the sand restoring machine. This latter machine distributes the cleaned sand, spreading it with such exactness that the surface is left entirely smooth. These machines are designed to operate in all the filters, and by this automatic apparatus there will be a great saving in the cost of maintenance of the plant after it has once been placed in commission, the city authorities claiming that this saving will amount to at least $25,000 a year.

The pipe galleries, as they are called, run in lines parallel with and between rows of filters, there being a gallery between every two tiers of filters. These galleries are fitted with the various pipe lines which carry the raw water into, and the filtered water out of, the filters, and they are also equipped with apparatus for measuring the flow into and out of the filters; they are also fitted with sand washing apparatus, quarters for

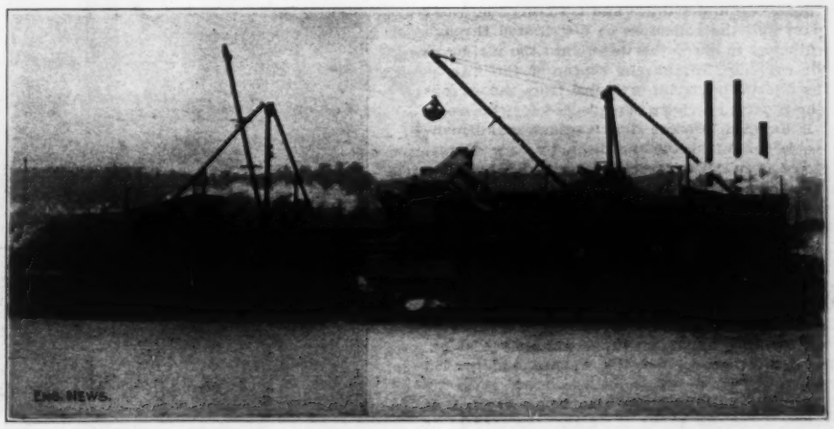


FIG. 5. MAIN DOCK, SHOWING CLAM-SHELL DERRICKS FOR HOISTING SAND AND GRAVEL FROM BARGES.

the attendants, piping and hose for the transportation of the filter sand, and are the means of entrance into the filters themselves. Each filter has a sluice door which opens onto the gallery, this door being 5 ft. 3 ins. in height and 7 ft. long, and is operated by hydraulic cylinders.

The contractors are required to place the filtering material in the filters ready for use. This

FIG. 6. INTERIOR OF FILTER BED, SHOWING CAR FOR DISTRIBUTING MATERIAL ON FLOOR OF FILTERS.

(Car is resting on Transfer Table of T-rail system. Lateral Tile Collectors on floor.)

has necessitated the installation of a large gravel screen, as well as a sand grading machine, already referred to. The gravel screen separates and grades the gravel to the proper sizes, the various sizes being placed in separate bins by this apparatus. The sand screen also grades the sand to the proper size, removing all foreign and undesirable materials. The four different sizes of gravel are placed in the filter to a total depth of 1 ft. and the sand is placed on top of this material to a depth of 4 ft. The gravel is placed in such a way that the coarsest materials come on the floor of the filter, the other three grades being placed, the finer on the coarser, until the top of the gravel is not much more than very coarse sand, it being required that this finest material shall pass through a screen having a clear mesh of ¼ in. On the top of this fine gravel the sand is placed to a depth of 4 ft., and it is by passing through this material that the raw water is purified, the sand acting as the filter and the gravel serving as an under-drain and assisting the water to pass into the collectors so distributed through the filter as to carry the water into the main collector running through the center of the filter.

The filtering material is hauled from the screens in dump carts specially constructed for the work, and is dumped into the filter through small manholes, is caught, inside the filter, by cars operating on the overhead track system, and by these cars (shown in Fig. 6), specially constructed for the purpose, the material is evenly distributed over the filter bed.

The gravel screen referred to is a huge steel cylinder about 43 ft. long and 42 ins. in diameter, made of steel plates, fitted at different points with screens of various sizes and so arranged that each size of gravel is deposited in a separate bin. By this apparatus approximately 250 cu. yds. of filter gravel may be washed and graded per day.

Numerous buildings are also being erected at different locations about the plant, the largest of these being the pumping station, at the eastern boundary of the work, on the north shore of the Allegheny river. In this building there will be installed four 36-in. centrifugal pumps, equipped with vertical cross-compound engines, which pumps supply the raw water for filtering, drawing it from the river and pumping it through the 96-in. steel main, to the receiving and sedimentation basins at the northern extremity of the plant. Each one of these pumps has a daily capacity of 35,000,000 gallons, with possible overload at short intervals. In addition to these there will be three d'Auria pumping engines, having a combined capacity of 13,000,000 gallons per day. Also a complete electric plant will be installed, as well as auxiliary machines of various types, and a battery of eight Aultman & Taylor water tube boilers, together with automatic coal and ash handling machinery, stokers, and all other essential apparatus required in the up-to-date boiler room. Connecting with the pumping station there will be a brick chimney, 200 ft. in height and 8 ft. 6 ins. in diameter, which is being constructed for the contractors by the Alphons Custodis Chimney Construction Co.

As the water leaves the large centrifugal pumps and enters the 96-in. rising main, it is accurately measured by means of a Venturi meter, which has been installed in the 96-in. line just outside the pumping station. This meter will measure with a variation of not more than 1,000 to 500,000 gallons per 100,000,000, all the water that passes through them. In this way, right at the start, the amount of water passing through the plant can be accurately ascertained, and by means of measuring apparatus at each of the filters, and at other points on the plant, a strict account may be kept of the volume of water being filtered and of the reduction in capacity of any filter as its time for cleaning approaches.

There will also be numerous gate houses and gate chambers at different points on the work, in the foundations of which there will be installed huge sluice gates and valves, the larger ones being operated by electricity, though fitted with attachments for hand-operation.

Besides all this, there is being placed in the ground many miles of steel pipe, ranging in diameter from 24 ins. to 96 ins. The largest steel pipe to be installed is the rising main, already mentioned, carrying the water from the pumping station to the sedimentation and receiving basins. From these basins the water will pass through many different lines of pipe running to the various filter galleries.

The longest line of steel pipe to be installed in connection with the work is the line which will carry the filtered water from the reservoirs in Highland Park, Pittsburg, across the main portion of the city, under the Monongahela river, to the South Side. This line is upwards of seven miles long, 50 ins. in diameter, except where it passes under the Monongahela river, where it is reduced to a diameter of 36 ins.

Under the bed of the Allegheny river there are being laid two lines of steel pipe, 72 ins. in diameter, which connect the filtered water reservoir on the north bank of the river with the Brilliant pumping station on the south bank. For the purpose of placing this pipe, it was necessary to construct three sections of cofferdam, one connecting with the north shore, another in the middle of the river, and the third connecting with the south bank at Brilliant station. Fig. 7 shows the third section of this cofferdam.

In the fall of 1905 the cofferdam work was flooded a number of times, the river then being very high. It became necessary, therefore, in constructing the other two sections, to greatly increase the strength and resisting power of this work. A larger plant was installed of derrick

FIG. 7. THIRD SECTION OF COFFERDAM FOR PIPE LINES ACROSS ALLEGHENY RIVER, SHEETED PIPE TRENCH STILL FILLED WITH WATER.

b[illegible], pile driver boats, sand diggers and pump b[illegible] and all combined to make this work a suc- [illegible] Some idea of the magnitude of this river [illegible] may be gained from an examination of Fig. [illegible] The pipe, after being placed in the trenches [illegible] riveted up, was covered with concrete, the [illegible]vated material replaced over the top, and [illegible] water then allowed to return to its original [illegible]ition, the cofferdam being removed as rapidly [illegible] possible.

The work of placing this river crossing has been probably the most hazardous and expensive part of the whole contract, owing to the treacherous nature of the Allegheny river at this point, and owing to the further fact that it was necessary to go far below the level of the river bottom and break through the crust of the river bed, in order to reach the elevation at which the pipe was to be placed. Especially in the case of the middle section, this depth of excavation within the cofferdam permitted the water to bubble up through the sand and gravel under-drain, and even after the cofferdam was completely water tight, the interior managed to keep filling up from these newly created springs. It, therefore, became necessary to install as many as eight 12-in. pumps to keep the water down to a working level, and even with this equipment it was barely possible to do so. This pumping plant had a capacity of 36,000,000 gallons per day, and even after the cofferdam had been banked, inside and out, with fine gravel and sand, to a height above the water level, these pumps barely kept the water down. It will be readily seen that this was one of the most difficult problems which the contractors had to solve, but the fact that the last sections of this pipe are all in and covered with concrete and that the connections with the Brilliant pumping station are practically made, show how successfully the problem has been met and overcome.

On the south bank of the river the Brilliant pumping station receives the filtered water and raises it up into the storage reservoirs at Highland Park. For the purpose of guaranteeing a sufficient supply of water at all times, two additional pumps are being installed by the contractors in the Brilliant station, these pumps having a capacity of 15,000,000 gals. each per day. There is also being installed a complete outfit of new boilers, similar to those being placed in the filtration pumping station, as well as the full boiler room equipment of mechanical stokers, coal handling apparatus, etc.

The work was begun in April, 1905, but it was not until July that the contractors' plant and forces were in full operation. The contract date for completion is Sept. 1, 1907. Throughout the entire work on the filtration plant the contractors have followed the policy of carrying on the work with the greatest speed consistent with good workmanship; and they have supplied a sufficient plant and force to finish the work on contract time, in any event. Thus in spite of rain and floods and many difficulties and delays, the work has steadily progressed and is now in a fair way to be completed within the time limit. This is a record which is quite unusual in the conduct of large municipal works, the prevalent idea seeming to be that public work should be prolonged to as great an extent as possible. The completion of this contract within the required time, which now seems to be a reasonable expectation, will be a notable achievement for the contracting firm.

THE WASHINGTON TYPHOID SITUATION AND HOW THE BALTIMORE WATER DEPARTMENT HAS PROTECTED ITS SUPPLY WITHOUT FILTRATION.

By Alfred M. Quick,* Assoc. M. Am. Soc. C. E.

I have read with great interest the articles in recent numbers of Engineering News on typhoid fever and the water filtration plant at Washington, D. C. I am not at all surprised that since the plant was put in operation there has been no material decrease in the number of typhoid fever cases there. Sanitary conditions and conditions favorable to typhoid infection are somewhat similar there to what they are in Baltimore, with the exception that Washington has more of a sewerage system than has Baltimore.

As we have had in Baltimore the same agitation for a water filtration plant to eliminate typhoid fever, *without* the result of spending millions of dollars for such a plant and then finding out afterwards that very little if any of the typhoid was eliminated thereby, some of your readers may be interested to know how the agitation was overcome, and what information was presented to combat it.

Right here I want to say that I am not opposed to filtration. In Washington it is undoubtedly absolutely necessary and wise to have the water filtered, even if the raw water never caused a single case of typhoid or any other disease. It may eventually be necessary in Baltimore also, although at present we are rapidly eliminating the cases of pollution in our drainage area and are committed to the plan (which is entirely feasible for us) of gradually acquiring and reforesting the drainage area and building immense storage reservoirs thereon.

For years health authorities, physicians, and others had constantly attributed all or nearly all of our numerous typhoid fever cases to the city water supply. Almost every year when the weekly or monthly number of typhoid fever cases reported reached a maximum some one or more of these people would publicly blame it on the city water, and the necessity of a filter plant would be agitated. Once in a while this agitation has reached an acute stage, making it necessary to take notice of it.

Although, from my intimate knowledge of our water supply system, I have always been satisfied that very little if any of the typhoid fever came from it, statements to the contrary from such weighty sources as health officials and prominent physicians made it necessary for me to fortify my belief with data sufficiently definite and convincing to have some weight with the public.

The claims of the filter plant agitators were all made without any but the vaguest idea of actual conditions in our drainage area, with no idea of what the water department was doing to prevent pollution there, especially from typhoid cases, apparently with no knowledge or realization of the many conditions outside of the city water supply which are especially favorable to prolific typhoid infection, and without ever having made any systematic effort to trace the sources of infection of the mass of typhoid cases.

The necessary data in relation to all of these matters except the last mentioned I could supply from my own records and general observation. The data on which I based my argument as to the improbability of infection from the city water supply were as follows:

The actual conditions on our drainage area in regard to pollution and typhoid fever are such as to make the possibility of infection from that source at least very doubtful. We have about 350 sq. miles of drainage area on which is a population of about 11,300. We have a record of every piece of property near enough to any stream, water course or ditch in the whole area to afford the possibility of pollution, whether there is any actual pollution from it or not, noting and locating all drains, cesspools, barn yards, hog pens, and the disposition of house slops on the property. In addition to these records we have made surveys of all settlements, and have plats made from these surveys showing every building, water course, drain, cesspool, barn yard, or hog pen, with the topography. From these surveys we have made plans in detail for abating the pollutions in the most important cases, including complete sewerage systems for all settlements. We also have devised inexpensive standard designs for filter boxes for house slops, sanitary privies, small modified Waring systems for properties having drains or cesspools, and drainage systems for barn yards. We devised and have carried out a systematic campaign to eliminate these pollutions, beginning with formal notice to the property owner, repeated personal persuasion by a drainage area inspector, repeated personal notes from the water engineer, and finally an injunction from the city solicitor. In this way we have secured in the last six years about 530 abatements of individual pollutions, mostly by persuasion, including the majority of the worst cases.

We go further than this where there are typhoid fever cases. We get reports from all of the health officers in all districts in the drainage area of cases of typhoid fever as soon as they occur. We do not depend entirely upon notices from the health officers, but make our own investigation and discover many cases which these officers do not report. We also do not depend upon the attending doctor giving the proper instructions or seeing that they are carried out, but we send our inspector at once to the property to see that all ejecta and cloths are properly disinfected and buried at a safe depth and distance from any stream. We also find out what water the patient has been drinking, and if from a well or spring in the neighborhood we have the water analyzed. If the analysis shows the presence of colon bacilli we see that the well or spring is closed up. There are only from 50 to 75 cases of typhoid fever in the drainage area each year.

If any pollution from typhoid cases gets into our sources of supply the chances of its infecting the consumer are very small. In the first place only about one-sixth of the total flow of our sources of supply is sent to the city for consumption. Of the amount sent to the city less than one-third is used as drinking water or comes into contact with food eaten raw. Between the nearest point of possible contamination on our impounding reservoirs and the nearest consumer on our mains there are, for each of our two sources of supply, three reservoirs and a tunnel having a combined capacity of from 26 to 41 days' supply. So that it would take approximately that length of time for any contamination to get to the consumers. In all of that time the germs would be subject to the action of sedimentation, sunlight and other adverse conditions that would tend to eliminate them.

The data on which I based my argument as to the greater probability of typhoid infection from sources outside of the city water was as follows:

Some Baltimore hospitals have been noted for their successful treatment of typhoid fever, and, consequently, a great many non-resident typhoid cases come to the city for treatment. Thousands of Baltimore people are natives of or have relatives in the counties of Maryland and Virginia and go there nearly every summer for vacations or trips. The water supply in most of these places is from surface wells, and it is known that scores of Baltimore people get infected from these sources and develop the disease before or soon after their return to Baltimore. There are numbers of small and unsanitary shore parks and fishing resorts on the Bay and its tributaries near Baltimore where thousands of Baltimore people go habitually every summer and drink water from surface wells and bathe in polluted water.

There are thousands of men and boys in Baltimore who bathe every summer habitually at one of the four outdoor public baths. One of these public bathhouses is on Gwynn's Falls, which is nothing but an open sewer into which many sewers carrying house sewage and all of the stockyards drain. The other three are on the city's water front, where the water is so foul from years of sewage discharge that the odor in summer is almost unbearable. The water at these bathhouses was analyzed once by the health department, and the analyses showed that it was about as foul as diluted sewage. One of these three bathhouses is not over 500 ft. below the wharf at which is loaded in scows nearly all of the night soil from the thousands of privies in Baltimore. (There were 72,000 different men and boys who bathed in these places last year, and besides these hundreds of others bathed in the same water outside of these bathhouses).

As we have no sewerage system for house drainage, gutters all over the city are flowing almost constantly with slop water from kitchen sinks, bathtubs, laundries and factories, and in

*Water Engineer, Water Department, Baltimore, Md.

many cases with the overflow from cesspools. Hundreds of children, especially in the poorer sections of the city, play with the water in these gutters.

All of the night soil from thousands of cesspools in the city is carried in teams and scows to truck farms in the country contiguous to Baltimore, stored in pits and then distributed as fertilizer on land where all sorts of vegetables are grown, including lettuce, cabbages, tomatoes, celery, radishes, and other vegetables which are eaten raw. Nearly all of these vegetables are sold in our markets and those from the North Point Neck, where this fertilizer is used almost exclusively, are considered to be especially fine.

Some of the dairies supplying the city with milk are known to be unsanitary. Although the health department is supposed to inspect the milk, it does not have the force or the appropriation necessary to make such a thorough inspection as to prevent some contaminated milk from getting into the city. (An epidemic of typhoid fever with over 100 cases occurred in one of the outlying sections of the city this year, which was positively traced to a contaminated milk supply from one dairy.)

Only a few years ago hundreds of surface wells were in use in the city. Numbers of these have been condemned every year, but many still remain in use. (128 of these were condemned this year as contaminated with intestinal bacteria, in the section of the city above-mentioned where the epidemic of typhoid fever occurred.) Nearly all of these wells were on the sidewalks of solidly built up streets or in back yards in close proximity to cesspools.

Until very recently ice was sold in Baltimore which was cut from a number of ponds (and I believe is yet cut from a few) which were formed by damming up small streams into which the sewage from numbers of houses drained.

Notwithstanding the fact that there is house sewage flowing into nearly every gutter and a cesspool in nearly every back yard, the great majority of houses in the city have not had (and thousands do not now have) any screens in windows or doors.

DATA FROM A CANVASS OF TYPHOID FEVER CASES.

Any positive information as to the source of infection of the mass of typhoid fever cases could only be obtained by a systematic canvass. This canvass I set out to make with some of the regular water department employees. Blanks were prepared with questions to be asked at every house or hospital where there were typhoid cases. We began about the first of July, the month in which a large increase in the number of cases first becomes noticeable, and continued our investigation through to about December. Lists of reported typhoid fever cases were obtained every day from the health department and the inspectors were sent out on these cases. Of course it was impossible for us to make a scientific investigation or such an investigation as could have been made by the health department with unlimited authority and a force of employees experienced in such work, but we aimed to determine the following facts: (1) Whether the patient came to the city sick with the disease, and if so whether a Baltimorean who had been away on a vacation or trip, or an outsider brought here for treatment. (2) Whether the patient had been out of the city at the time of infection though not actually down sick at the time of arrival in Baltimore. (3) If the patient had not been out of the city for an extended stay, whether he or she had not been to one of the shore places or parks outside the city about the time of infection. (4) Whether the patient used habitually spring water or pump water from one of the numerous surface wells on streets or in back yards. (5) Whether the patient had been bathing about the time of infection in the polluted rivers or basin, either at one of the public bathhouses or elsewhere. (6) Whether the patient was a child of the class apt to play in the gutter with gutter water. (7) And whether the case was obviously caused by secondary infection.

This canvass showed that in about two-thirds of the hundreds of cases investigated the patient was infected when out of the city, and that in a sufficient additional number of cases to make a total of about three-quarters of all investigated it was practically certain that the infection was from some source outside of the city water supply.

It was, of course, impossible for us to investigate the milk, ice, or vegetable supply in these cases, or to determine whether any of them were caused by infected oysters or infection from flies. All of these are generally recognized and admitted to be possible sources of infection that might have caused some at least of the remaining 25% of the cases.

The presentation of these facts has apparently been sufficiently convincing that the city water supply is not responsible for any considerable proportion of our typhoid fever cases to stop the agitation, for the present at least, for a filter plant to reduce the amount of typhoid.

It should be stated that the construction of a complete system for the collection and purification of all house sewage and factory waste, which is now under way here, will remove a number of the present unsanitary conditions. It will eliminate all of the gutter drainage, all of the cesspools, all of the night soil fertilizing, and will remove from the basin and the streams flowing through the city all of the sewage which now pollutes them.

DREDGING OPERATIONS AT WARROAD, LAKE OF THE WOODS MINN., BY THE U. S. GOVERNMENT.

By Emile Low.*

In Engineering News of Sept. 20, 1906, there appeared an article on dredging in New York Harbor, by hydraulic hopper dredges owned and operated by the U. S. Government, in which an extremely economical working was demonstrated. Attention is now called to another dredging work, under the direct operation of the U. S. Engineer Corps, at Warroad River, Minn. Warroad River is for a short distance a navigable tributary of the Lake of the Woods, which lake is a large body of water covering about 1,500 square miles. The present improvement consists of dredging a channel at the mouth of the river and across the outer bar. To carry this improvement a dredging plant, consisting of a dredge, wood barge, pipe floats and small boats, was constructed at a total cost of $29,130.

The dredge, as shown, is of the "seagoing hopper type," with stern wheel, but is also adapted and equipped for use with a supported discharge pipe for river channel and river harbor dredging.

The dimensions of dredge are: Length of hull, 100 ft.; width midship at main deck, 27 ft.; depth of hull midship, 8 ft. 6 ins.; length over all, including stern wheel and revolving cutter on the bow, 158 ft.; height of hull and superstructure, k[illegible] to top of cabin transom, 25 ft. 4 ins.; draft [illegible]nt, 4 ft. 2 ins.; draft loaded, 6 ft. 4 ins. The [illegible]d pit, located midship of the hull, is of 100 cu. [illegible]s. capacity and is operated by ten shutters [illegible]- trolled by hand-power worm gears.

The machinery of the dredge consists of [illegible]o 12-in. centrifugal pumps; one 16-HP. vertica[illegible]- gine operating the revolving cutter; one 20-[illegible]p. horizontal engine operating the cutter hoist, c[illegible]n drums, and rope spools; two 10 × 60-in. s[illegible]n wheel engines; one 6 × 10-in. duplex force pu[illegible]p, and four hand-power worm gears for manipu[illegible]- ing the sand pit shutters. The power is supp[illegible]d by two 75-HP. Scotch marine boilers.

The centrifugal pumps are arranged to t[illegible]e material through trailing suction ends from b[illegible]h sides of the dredge, and one of the pumps is [illegible]e connected with the suction end of the revolv[illegible]g cutter, for dredging in clay or other hard m[illegible]- terial.

The dredge commenced operations on May [illegible], 1904, and between that date and June 30, 190[illegible], accomplished the excavation of 1,380 lin. ft. [illegible]f channel, with an average width of 100 ft., and mean depth of 8 ft. The total excavation was 8,625 cu. yds., at an average cost of 21 2-3 cts. per cu. yd., all expenses—labor, fuel, supplies, subsistence, etc.—included. The cost of subsistence per ration was 44 cts.

Owing to the very low stage of water in the Lake of the Woods, the dredge worked at a disadvantage, only one centrifugal pump being used with the revolving cutter, and the working capacity of the dredge being thus reduced one-half.

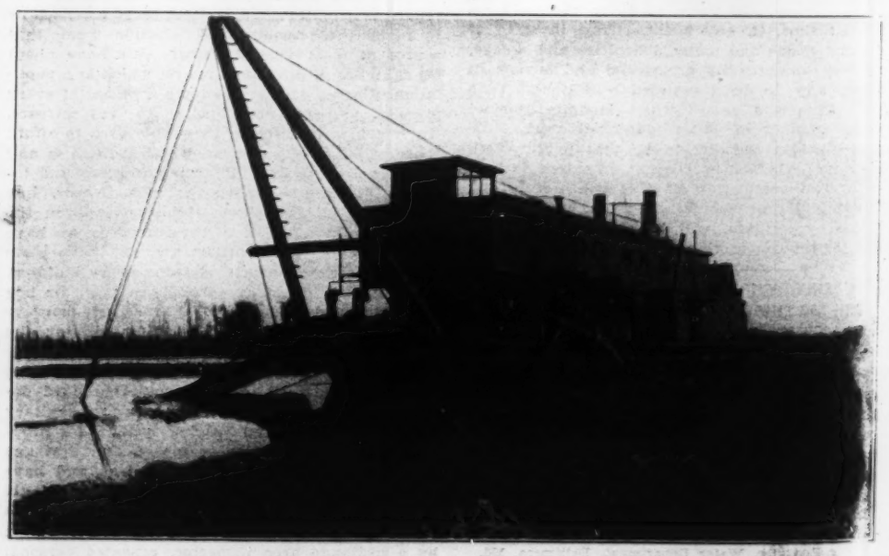
The material dredged was about equal quantities of hardpan and mud, the latter full of the tough, fibrous roots of the bulrush and other aquatic plants. Stormy weather, wind and sea from the open lake delayed the work 5½ days.

Between July 1, 1904, and Oct. 29, 1904, the dredge excavated 26,923 cu. yds., the average daily rate being 259 cu. yds. The material was the same as mentioned above. Stormy weather, wind and sea delayed the work 12.3 days.

Between April 24 and June 30, 1905, the total excavation was 28,282 cu. yds., with a daily average excavation of 479 cu. yds. The material dredged during the period mentioned was mainly hardpan, requiring the constant use of the revolving cutter, but being free from plant roots, was more readily taken up by the pumps than the material dredged during the season of 1904. The time lost during the season of 1905 was 12.65 days.

The total excavation for the fiscal year, July 1, 1904, to June 30, 1905, was 55,205 cu. yds. The average cost of excavation (excluding charges on account of the plant used) was 13.03 cts. per cu. yd., and the cost of subsistence per ration, 39 cts.

*Barge Canal Resident Engineer, Department of State Engineers, Rome, N. Y.



VIEW OF U. S. DREDGE AT WARROAD, MINN., SHOWING ARRANGEMENT OF SUCTION AND DISCHARGE PIPES.

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The remarkable work done by the water department of Baltimore, Md., to protect its water supply from pollution is well described by Mr. Alfred M. Quick elsewhere in this issue. Few cities have such efforts to their credit as Mr. Quick describes. It will be seen that the Baltimore water department has not rested with looking sharply after its water supply, but has made investigations designed to place the responsibility for typhoid where it belongs—on the general unsanitary conditions of the city. Those conditions are unusual for a city of more than half a million people, largely on account of the absence of a sewerage system for the removal of household wastes. It will be interesting to see what effect the sewerage system about to be constructed has on the typhoid and the general death rates of Baltimore.

While we do not for a moment question the wisdom, thus far, and perhaps for many years hence, of relying upon the sanitary control of the Baltimore drainage area rather than upon filtration to protect that city from typhoid, we believe the time will come when water filtration there will be rightfully demanded. For the present, however, the money that filtration would cost can be spent to far better advantage in other and greatly needed sanitary reforms. Besides the heavy outlay to be made for sewerage and sewage disposal attention should be given to the sanitary protection of the milk and vegetable supplies and to the provision of decent and sanitary public bathing places. The fact that the water department undertook the general investigation of causes of typhoid described by Mr. Quick indicates a serious deficiency in the city health department, due either to lack of money or proper administration. Perhaps this deficiency has been made good by this time. If not, some thousands of dollars and a few well-trained fearless men should be provided, and the latter, clothed with needed authority, should be put to work. It is creditable to a water department to make such a general study of typhoid as Mr. Quick describes, but discreditable to any health department *not* to have all this information, and more of the same kind, constantly on file.

Finally, we must call attention, as does Mr. Quick, to the leading part played by a very long period of sedimentation in rendering the Baltimore water supply notably free from suspicion. A few days sedimentation at Washington, it will be remembered, effects a wonderful bacterial reduction, and if so what is to be expected from many times as long a period of sedimentation at Baltimore? It is, of course, no news that long storage is of immense benefit to a water supply. This was pointed out by Professor Frankland in the early days of water supply bacteriology, when he studied the effects of both sedimentation and filtration on the water supply of London. Without belittling in the least the benefits of the sanitary survey and patrol of the Baltimore gathering grounds we feel it our duty to say that without a long period of sedimentation these measures might prove at any time, though not generally, mere broken reeds. Few cities have such huge water storage facilities as Baltimore enjoys, and many cities take their water from such large drainage areas as to make a complete sanitary control utterly impracticable. Nor can every city rely upon the cooperation of the rural health officers in its drainage areas to report typhoid cases.

That the overcrowded street car is a dangerous place, so far as exposure to infection from communicable diseases is concerned, is indicated by the following extract from the Bulletin of the Chicago Health Department for the week ending Nov. 17, 1906:

Bacteriologic examinations of the air of street cars made by the Laboratory disclose the fact that in 146 examinations the number of bacteria in cars with all the seats occupied, averaged four times more than the number in the outside air. In cars that were crowded by "strap hangers" during the rush hours in the morning and evening, the number of bacteria showed an increase equal to 26 times that of the same cars when only the seats were occupied by passengers.

In an examination of sputa collected from the floors and platforms of the cars, tubercle bacilli were found 4 times, influenza bacilli 12 times and pneumococci 9 times out of 17 examinations—some of the specimens containing both the latter organizms. No effort by conductors to prevent spitting in the cars was observed during these examinations.

The need of some restriction of overcrowding and of effective cleansing and disinfection of the street cars could not be more strikingly shown.

The Department renews its oft-repeated advice: Shun the overcrowded, filthy, disease-breeding street car. The able-bodied should walk any reasonable distance rather than enter one. If the entire distance be too great to walk, get out and walk the last mile or so. The exercise in the open air will help disinfect the air passages.

We presume that few people will heed the advice to shun the street cars and fewer yet will take the precaution to "walk the last mile or so," but the suggestions are worth following where practicable. The case against the street car (and that term includes elevated, subway and all other urban trains packed with the mixed crowds that result from nickel fares) is even worse than is made out by the foregoing indictment, for in it no account is taken of infection (really contagion) due to direct contact with the hands and the clothing of people suffering from communicable diseases or coming from houses where such diseases prevail. To name only a few dangers not specifically mentioned in the paragraphs cited: The desquamating hand of the small child just up from scarlet fever is everywhere touching other passengers, young and old, and rubbing over the seats and other accessible portions of the cars. The soiled hand of the ignorant and careless person suffering from (or perhaps unaware of) "walking typhoid" is equally ubiquitous, reaching to the rough and greasy hanging strap and leaving, perchance, a numerous collection of typhoid germs there. More insidious still is the exposure of children to measles and to whooping cough, regarding the spread of which so little is known, except that they spread like wildfire and, particularly measles, before the disease is recognized. As we have suggested, all the warnings that may be given cannot be expected to keep many people from traveling on street cars, but it is possible for some to choose a time for their trips when the travel, and especially the travel of the dirtiest and most dangerous classes, is at the minimum, and much of the infection which children cause and to which they are subjected might be prevented by leaving them at home. More practicable and far-reaching a means of reducing the dangers incident to street cars are the suggestions made in the Bulletin for thorough cleansing and disinfecting of cars, which should be done at frequent intervals and under competent and rigid municipal supervision. The whole subject is worthy of attention by the municipal authorities and sanitarians of the country.

Tin as a roofing material has fallen far in reputation during the past few years, on account of the substitution of steel sheets for wrought iron and the competition among manufacturers to reduce the tin coating to the thinnest possible wash. The old-time tin roof, laid by honest workmen, was expected to last and often did last for more than a generation. The present day tin roof has such a facility for developing leaks that architects, builders and owners have learned to avoid its use wherever any other roofing will answer.

In recognition of this unfortunate condition, the largest producer of tin plate, the American Sheet Tin Plate Co., has announced that hereafter it will stamp every sheet of its roofing plate with the number of pounds of coating it carries per box of 20 × 28 in. plates. The departure is certainly a commendable one, and will no doubt be followed by other makers of roofing plates. It has been heralded by some of the trade journals as a revolution in the industry. One of these journals in a paroxysm of eloquence remarks:

This move crushes the malpractice of years in one fell stroke, and with firm grasp uplifts the business to a plane of dignity and honor.

We trust this is all true; but before we join in the chorus we would like to inquire whether the buyer is to be informed how much lead and how much tin goes into the coating of the terne plates which he purchases. Tin costs now about 45 cts. per lb.; lead costs a little over 6 cts. If the buyer of roofing plates is to be told how many pounds of coating have been applied to the sheets he buys, he might also be informed how much of that coating is tin and how much lead.

The advance figures of railway earnings collected by the Interstate Commerce Commission, for the fiscal year ending June 30, 1906, have just been made public and the comparison between them and the figures for the previous year from Poor's Manual, published on p. 545 of our last issue, is an interesting one. In general, the year just closed has been by far the most profitable that railways of the United States have ever seen. Gross earnings which were in round numbers 2,100 million dollars in 1905 increased to 2,300 million dollars in 1906; the growth per mile was from $9,643 in 1905 to $10,543 in 1906. The comparison in passenger and freight earnings and in net earnings is:

	1905.	1906.
Pass. earnings per mile of road	$2,269	$2,811
Freight earnings per mile of road	6,840	7,458
Net earnings per mile of road	3,129	3,580

The total net earnings were 787 million dollars in 1906 as compared with 685 million dollars in the previous year. Dividends grew from 204 million dollars in 1905 to 229 million dollars in 1906, and 100 million dollars was added to the companies' surplus account.

While the statistics of 1905 are compiled by Poor and of 1906 by the Government and there is some slight difference in the methods of the two statistical organizations, the differences are not sufficient to make a material alteration in the general showing.

In our issue of Oct. 11, in the "Situations Open" column, there was published an advertisement for engineers to take service on railway locating parties, in South America, signed by C. Hartley, Pasadena, Cal. We now learn from Los Angeles daily papers of Nov. 16 that the party who inserted this advertisement was arrested on Nov. 15 on charge of obtaining money under false pretenses and impersonating a Federal officer. We quote from the Los Angeles Examiner as follows:

After claiming that he was the only American agent for the Pan-American Railway Company, and alleging he was an agent of the United States Secret Service Department, Charles Hartley, alias Captain Charles Hartley of West Point, was arrested by Secret Service Officers Jack Cronin and G. W. Hazen at Arrowhead,

San Bernardino County, yesterday, on a charge of embezzlement and for the alleged impersonation of a secret service agent.

Hartley was brought to Los Angeles yesterday afternoon and is now held at the city jail pending an examination in the Federal Court to-day.

When arrested, Hartley was employed by the Arrowhead Reservoir Company, and, it is alleged, attempted to interest men of wealth in a scheme of building a railroad to Panama.

Before going to San Bernardino County, Hartley was employed in Pasadena by Allin Brothers, civil engineers. While in their employ he is said to have interested a number of city officials in a scheme to purify the city sewage into pure water.

Before leaving Pasadena, Hartley sold to Councilman Loughery an interest for $150 in his scheme to purify sewage. At the same time he attempted to interest capital in his railroad scheme. He advertised extensively for engineers to work on the project. Then he suddenly left, saying he was headed for Arizona to arrest a band of counterfeiters.

The authorities at Pasadena were notified of his disappearance. Numerous small bills were said to have been left unpaid by him. He was next heard of at Arrowhead and there he told Vice-President Victor Smith of the Arrowhead Reservoir Company, of his Panama railroad scheme and tried to interest capital in the project. It is not known whether he succeeded to any extent, but secret service officers say he sold alleged stock to several parties.

According to Cronin and Hazen, the agent for the company is J. M. Neeland, of the Grosse Building, Los Angeles, and the engineer for the concern is Chas. E. Miller, of San Francisco.

A correspondent in Southern California writes us that the secret service officials found that Hartley had received over 400 replies to his advertisement in Engineering News. These replies are now in the custody of Mr. John F. Cronin, Agent U. S. Secret Service, 307 Citizens National Bank Building, Los Angeles. Any who sent original letters of recommendation to Hartley should apply to Mr. Cronin for their return.

We sincerely regret the publication of the fraudulent advertisement; but it was forwarded to us with nothing to indicate that it was not inserted in good faith.

Apropos of the above advertisement, our correspondent also writes that the great majority of the replies indicated that the writers knew nothing whatever of the actual work or hardships involved in railway surveys in Spanish America. Very few could speak Spanish and most of them were young college graduates of a few years experience, with no idea of the make-up of a typical pioneer engineer. Engineers on railway surveys in Spanish American countries must live much of the time on native food (corn, etc.), prepared by the Indians in the same crude way that it has been done for centuries. They must sleep wherever night overtakes them; and on reconnaisance work particularly, must suffer all sorts of torment from insects and other vermin.

SHALL INVESTIGATION OF THE WATER RESOURCES OF THE UNITED STATES BE CONTINUED?

An unexpected blow was struck at the stream gagings and other valuable hydrographic investigations of the U. S. Geological Survey last June in the form of an attempt to kill the appropriation for the continuance of the work. The blow was partly warded off, inasmuch as an appropriation for the year 1906-7 was made, although $50,000 or 25% less than the amounts appropriated for the four previous years. Every engineer knows that the value of stream gagings depends largely upon their unbroken continuance through a period of years sufficiently long to cover the whole range of conditions that affect stream flow. The most important and most variable of these conditions is rainfall, and its extreme fluctuations often extend over a long period of years. None of the stream gagings in question have been conducted for so long a time as to make their discontinuance advisable, while most of them, owing to the small size of the early appropriations, are now only fairly under way. A curtailment of appropriations for such work not only detracts greatly from the value of the records already secured, but it also both delays and increases the cost of rounding out the record for the cycle of years necessary to complete the data. It is therefore an extravagance rather than an economy to curtail the sums available for stream gagings, unless it is decided that the curtailment shall be permanent. Some members of Congress, it appears, were strenuous for abandonment rather than curtailment of stream gaging work.

Why this opposition to stream gagings arose we do not know, and in the absence of knowledge we assume that in their annual attempt to keep the total government appropriations down to what they considered to be some approach to a reasonable total the watch dogs of the treasury must have hit upon the item for hydrographic investigations as a point of least resistance. The outcome proved that they were at least partly right, since there was not sufficient rallying to the support of the appropriation to save a loss of one-fourth of the usual sum.

We believe that this reduction of funds for the study of the water resources of the United States would never have occurred had the engineers of the country suspected that an attack on the appropriation was to be made. Nevertheless, the engineers are doubtless partly to blame for the attack and its result, for they have taken the stream gagings and the related work of the U. S. Geological Survey altogether too much as a matter of course, doing but little to show their representatives in Congress that the work is of great value to them. Now that the utter discontinuance of the work has been threatened and its partial discontinuance achieved it may be expected that engineers, municipal officials, irrigationists, users of water for power and for a great variety of industrial purposes will join in making known to their Senators and Representatives in Congress how much the work in question means to them.

This is the time for any one interested in the continuance of stream gagings, and of studies of underground waters and of the qualities of both surface and ground waters, as well as the prevention of their pollution, to make his views known and his influence felt, for the "short session" of Congress will soon open, and during its course the appropriation bills for 1907-8 will be passed. The shortness of the session means haste and confusion, and if the hydrological survey item is again found to be a point of least resistance in the appropriation bill a further cut may be expected, if the item is not struck out entirely.

We have already said that we do not know the grounds of opposition to the studies of the water resources of the country. In the discussion on the appropriation it was maintained, but we can hardly believe that this was more than a veil of disguise, that there is no legal authority for placing funds at the disposal of the U. S. Geological Survey

> for gaging the streams and determining the water resources of the United States, and for the investigation of underground currents and artesian wells, and for the preparation of reports upon the best methods of utilizing the water resources [language of the appropriation bill].

In support of this contention it was urged in Congress that the U. S. Geological Survey had no authority to investigate water resources, it being quite overlooked that water is by far the most etxensive and valuable mineral resource of any country. It is quite unnecessary for us to go into this or other points connected with the legal authority of the U. S. Geological Survey to carry on water supply investigations. If there be any defects in the statutes under which authority for such work is claimed, those defects can doubtless be easily remedied. That there are such defects, however, seems doubtful and that expenditure for such work has met with general approval heretofore seems certain, in view of the fact that for 12 successive years appropriations for hydrographic surveys have been made. These began with $12,500 for 1894-5, and were continued with $20,000 the following year, $50,000 a year for the next four years, $100,000 for the three years ending with 1901-2 and $200,000 for the next four years; appropriation for the current fiscal year being as already stated. After such a long series of increasing appropriations, a claim of lack of legal authority seems belated.

Most of the readers of Engineering News are familiar with the hydrographic work of the U. S. Geological Survey, or at least some of its phases. Those who are not or who are informed as to only a portion of it may be interested to know somewhat about its scope, character and usefulness. The great number and wide distribution of the stream gaging stations are graphically exhibited by the accompanying map, reproduced from one of the 14 water supply papers required to present the stream measurements made during 1905 at some 800 stations. Extensive studies of underground water resources, varied to meet local conditions, have been made for years past and published in various forms. Some of these involve considerations of the geologic structure of large areas and others are concerned merely with the physical characteristics of individual wells, while still others go into methods and costs of pumping well waters. A third line of investigation carried on by the survey is the study of stream and lake pollution; both for the whole of a river or lake, and at some point or points where there is pollution by a single industry, as strawboard wastes or acid-iron wastes from iron works; each being typical of more or less widespread and unusually troublesome sources of pollution. Large numbers of water samples have been analyzed in connection with pollution studies, and much work has been done in the interests of uniform methods of making and reporting water analyses, on the part of state, municipal, university, industrial and private laboratories. Eventually it is to be hoped and expected that water analyses through this and other agencies having been put on a fairly comparable basis, the Survey will gather and publish analyses for the principal streams of the country, and likewise for typical underground waters in various parts of the United States. Already it has brought together in one useful paper the normal chlorine figures and maps of a number of states; while in another and even more useful paper it has presented the legislation of the various states on the subject of water pollution.

The foregoing is a very meager outline of the activities of the hydrographic branch of the U. S. Geological Survey, but it is intended chiefly as a reminder to those already cognizant of its work.

A few words may be said as to why engineers and others interested may properly look to the national government for such information. First of all, a large portion of both the surface and underground resources of the country are interstate in character, and can be studied as a whole only by the national government. Next, it may be noted, such studies are generally too vast, and at the same time useful to so great a number of people, to be carried on by any ordinary person, private corporation or city, particularly as most of them must be extended over long terms of years before reliable deductions can be drawn from them. Moreover, it is rarely the case that such water supply studies as are made at private or at municipal expense become generally available to all interested, while only rarely if ever do the results of even state investigations attain as wide circulation as they deserve. Information regarding a great, universally distributed, indispensable natural resource like water, on which the very life as well as prosperity of all the pepole depends, should be available to all.

Before the U. S. Geological Survey began its water supply investigations practically the whole United States was dependent for stream flow data on the gagings made by the water departments of Boston, New York, Philadelphia, the owners of a few Massachusetts and New Jersey water powers, and some scattering and generally meager far Western gagings. Needless to say much doubt, hesitancy, error, and money loss, and in addition many evils incident to municipal water famines, resulted from this general lack of data and from attempts to apply the data of

one locality to another section governed by far different conditions. The losses suffered by the irrigation interests of the Far West, on account of lack of water supply data, were almost beyond estimate, greatly retarded the development of that section, and reacted harmfully on the whole country. Although less obvious and less spectacular, the losses due to lack of underground water data have perhaps been more disastrous. If the work of the U. S. Geological Survey in supplying these deficiencies of data is as valuable as we think, certainly every reader of Engineering News should lose no time in bringing the fact before his Congressional representatives and once having done this every succeeding opportunity to deepening the impression made on the Congressional mind should also be seized.

THE LESSON FROM RECENT FAILURES OF REINFORCED CONCRETE STRUCTURES.

Carelessness, incompetence and unscrupulous skinning appear to have about reached the limit in reinforced-concrete construction. Two failures of large buildings under construction, occurring within a fortnight of each other, both of which had their harvest of dead, is a serious blemish on the record of reinforced concrete. A radical reform is imperative. The gray of our concrete structures is already too much stained with blood. Shall we allow that stain to spread and grow still darker?

Where are we to find relief? The theory is that the Law gives protection against rapacity and loose conscience so exercised as to harm another or injure the public. Has it done so in reinforced-concrete building? The method of the Law is to prevent by prescribing and enforcing penalties. The events of recent years—not to go into ancient history—show no case, in the scores and scores of building disasters, where the Law has laid its hand on the guilty and enforced its penalties. In many cases, to be sure, the antiquated and inadequate machinery of the coroner's office has made some ponderous movements, called "inquest" or "investigation," but with uniform fruitlessness. Public assignment of blame, or criminal conviction, have not been obtained. The discouragement of future offenders, upon which alone the law relies for its enforcement, has been totally absent. And the inevitable result has duly appeared. The unscrupulous and negligent, those who accept gain of any shade or odor so long as they can keep clear of grand juries, have grown bolder and more confident of security, and ply their nefarious business on a larger scale than ever.

The practice that constructs buildings and bridges which collapse must be eradicated. The interests of every element of the engineering profession demand this, no less than public safety. We must seek out and identify the source of the conditions which are at the bottom of the trouble, and by eliminating it bring about improvement. Let us examine some aspects of reinforced-concrete failures with this in view.

There is one feature that is common to virtually all failures of reinforced-concrete construction, and it is on this account almost a characteristic. This feature lies in the causes advanced, for any given failure, by the parties who have the most intimate knowledge of the structure, namely the executing force and the persons responsible for the design of the structure which failed. The designer or designers say, unqualifiedly, that the force of workman or their foreman, was at fault: that the concrete was of improper quality, or the reinforcement was not placed where directed, or care was not taken to bond together the several sections of concrete, or the green work was overloaded, or the centering was removed too soon. One or more of these defects has been given as the cause in every instance of such failures. The defects alleged would, if true, be a sufficient explanation of the collapse in nearly every case. But for the most part they have never been and can never be proved. The work whose character is impugned lies in a rubbish-heap, whence it is impossible to extract supporting evidence. It is to be noted, however, that for the same reason it is *impossible to disprove* such allegations of defect absolutely. On the other hand, the executing force, which usually contributed the victims of the collapse, claims that the work was done as directed and that the fault must lie in the design. The fact that the structure which failed was made of the same cement, the same mixture, and with the same care, as adjoining structures of the same building, is cited as proof that the fault could not lie in the workmanship and therefore must lie in the design; but of course this argument works both ways. Again, the fact is cited that the same workmen and foreman habitually removed the centering of concrete work at the same relative period as in the case of the failure; but this argument also is of doubtful effect.

We will return in a later paragraph to this divergence of statement as to cause, and note for the present only the resulting course of any "investigation" which may be instituted. Such investigations are, under the prevailing system, conducted by the coroner with the aid of a jury of citizens. Both the coroner and his jury are as able (or unable) to hold views and pass opinions on reinforced concrete as to judge whether a fossil bone belonged to a dinosaur or a pterodactyl. These gentlemen listen to the architect's statement (if an architect be concerned in the case) that the design and materials were of standard quality, by all his professional experience. Then they hear the testimony of workmen employed on the job, who say among other things that no evidence of weakness appeared at any time previous to the collapse, and that the section which collapsed was constructed in the same way and with the same care as other sections which remained standing. Finally they listen to the reinforced-concrete man, who "points with pride" to structures he has previously built without accident, and informs the jury that the reinforcing steel had a strength of 60,000 pounds to the square inch so that the structure should have (and, as test results on previous occasions showed, *must* have) been capable of carrying an enormous load with safety, whereas at the time of collapse it carried only a few planks and beams and half a dozen cement sacks. Thereupon, hearing further that sand and gravel sometimes have streaks of unnatural viciousness which may unaccountably produce a weak spot in the concrete, the jury brings in a verdict stating that the collapse was due to an unknown weakness in the concrete work, for which the jury is unable to hold any individual responsible. And having thus done its duty, the jury disbands, the coroner goes home satisfied, and the matter is ended!

We have already mentioned, by implication, that an architect is not always present in such a case. Some buildings (shops for example) are designed and built without recourse to an architect, because the architect's two or five per cent. would accomplish nothing but the addition of some decorative features. The owner, in such cases, supplies governing dimensions, heights and general arrangement of space, from which the bidders elaborate a design of structure. In most cases, however (hotels, dwellings, city buildings generally,) the general plans are made by an architect, who sometimes also superintends the construction work. Since the early days of the steel-frame building it is quite common practice for architects to have the designing of structural parts, fireproofing, floors, etc., done by bidders. This practice, which frequently results in giving the contract to the party that can "skin" the material the closest (unless, indeed, the job is "arranged for" beforehand,) has been carried over into reinforced-concrete construction, where it is, we may say, universal. The result is that the architect supplies the general arrangement of space and the interior and exterior shaping and decoration and accessories, but has no responsible connection with the design for strength. In one aspect this may be considered as the collaboration of an architect with a consulting engineer, except that the prospective contractor "does the engineering," without extra charge!

The proper collaboration of architect and engineer is, of course, an excellent way of working out a good design. But it is extremely uncommon for a consulting engineer to be employed on reinforced-concrete structures. It is considered a waste of money, and by the prospective contractor an undesired reflection on his ability and honesty. The reinforced-concrete contractor says: "I built this building for A, and that one for B, and made a record on price and speed on this other building for C," and he further presents testimonials from A, B and C, and their several architects. He wants the job, and wants it on his own design, without being bound by some one else's specifications or having some one else check the sufficiency of his design or construction. A load test is easily arranged for, and the "factor of safety" will take care of a multitude of sins.

It is unnecessary to recall to our readers the palmy days of highway bridge building, the days when the collaboration of county commissioners, bridge agents and pools, with careful exclusion of the consulting engineer, resulted in the erection of a merry lot of spider-web highway bridges all over the country. But it may be more profitable to call to mind that, by every experience of human nature, it is a fatal error for one man (an architect or owner) to put his interest without guard at the mercy of another (a contractor) when the latter's interest is in conflict with the former's. And nothing is better established in construction work than that contractor and contractee are necessarily opposed interests, in whose contest for advantage there are required, to conserve fairly the interests of both, not only the voluminous provisions of Contract Law but also the watchful eye and directing work of an impartial referee, the engineer. In the practice of reinforced-concrete construction this firmly-established fact has been ignored completely. The method of the early highway bridge times has been picked out of the scrap-heap and again pressed into busy service. The evil consequences known of old have not tarried in appearing.

We have already suggested, if not stated, that "investigations" of the kind commonly made in this country never attempt to examine into the sufficiency of design. In principal part this is due to the character of the investigating tribunals, coroner's juries. But a contributory effect is produced by the absence of any authoritative recommendation, agreement or standard for permissible stresses and other bases of design in reinforced concrete. A lay investigating body must therefore rely, for its criterion of safety or danger, to apply to a particular design, on expert testimony. Now the standing of expert opinion in American criminal jurisprudence is not high. Lawyers, judges, juries and the public have too often seen armies of experts for opposite sides of a case swear to radically different "opinions," and they have, not altogether unjustly, come to believe that an expert is a man of plausible antecedents employed to deliver an opinion favorable to the side which hires him. Whether for this or for other reasons, coroner's investigations rarely call upon expert testimony for assistance. In the reinforced-concrete field, particularly, the fact that the men of most experience are in the contracting ranks and hence are either partisans or opponents of the contractor whose work collapsed, doubtless militates against the calling of experts to pass on the design. As a matter of fact we know of not one case, in this country, where the public investigation of a reinforced-concrete failure involved serious study of the design, or resulted in impeaching the sufficiency of the design.

It is only in the rarest cases that a courageous *private* investigator lays bare the design (as did for instance Mr. D. B. Luten in our issue of Sept. 27, 1906, p. 337, in the case of a small reinforced-concrete highway bridge) and shows that incompetence or criminal skimping is evident, and that the failure may be explained without invoking the threadbare excuse of improper workmanship. In all other cases, public investigation of the design being absent, the facts as to the plans to which the structure was built never become known, and the proper location of the

blame for the faulty structure is therefore effectually concealed. Under the current commercial arrangements only two or three parties appear concerned in reinforced-concrete failures: the owner and the contractor (who also supplied the design,) or the owner, the architect and the contractor (where again the contractor furnished the design). None of these parties has any interest in a thorough investigation of the accident to determine its causes.

The result of the conditions stated is that the bulk of our knowledge concerning the causes of the failures of reinforced-concrete structures consists of ex parte but opposed statements, before mentioned, which are made by the parties most familiar with the individual case. Under these circumstances it appears inevitable that some degree of credence should be given to each side. That is, the opinion is deduced that, usually, the design is somewhat at fault, and also that, usually, the execution was not all it should have been. In default of more specific knowledge, the net result is that both design and workmanship are put under serious suspicion. Be it noted that both are of "commercial" grade. It is possible that more skilful and intelligent labor might be enlisted for the construction, and it is certain that designs of larger safety-margin would be employed. But for the moment both the commercial grade of labor and the commercial grade of design must be taken as they are: the suspicion rests on the *customary* grades. When considered each by itself, both may be proper; we do not attempt to impugn their intrinsic virtue. But the point is: if we cannot, or commercially do not, obtain such a grade of labor as to erect safely our designs of reinforced-concrete structures; or if we do not, or will not, design our structures with ample enough strength to permit of safe erection by the commercial grade of labor; then it is indeed time to call a halt.

The public must take the facts, dependent on present conditions, at their face value. It observes that alarming numbers of failures of reinforced-concrete work are recorded in the news of the day. It learns vaguely that each of these failures has been blamed upon improper workmanship or disobedience of workmen, on the one hand, and upon scanty design, or design unsuitable of safe execution by the grade of labor employed for the work, on the other hand. These observed facts impel the lay reader to one definite conclusion: That reinforced concrete is a dangerous building material, dangerous for unknown reasons, among which may be these: either (1) because safe methods of design have not yet been developed, or (2) because the commercially-obtainable materials of construction are subject to unknown variations which may produce fatal weakness, or (3) because the quality of labor employed is not high enough to ensure the safe construction of the design, even though design and materials be satisfactory.

To this conclusion we are regretfully forced to subscribe. We make but one reservation, namely, that, if an independent engineer be employed to either work out the design, or to prescribe specifications and verify the design by them; and if further an independent engineer be placed in charge of the construction work to see that it is properly done; then reinforced-concrete construction is as safe as other types of construction. Under all other circumstances, we believe, it involves so much risk that it must be characterized as dangerous.

LETTERS TO THE EDITOR.

Inside Guard Rails Omitted and the Result.

Sir: Speaking of guard rails on bridges, reminds me that the Henderson, Ky., bridge of the Louisville & Nashville Ry. has an approach from the Indiana side about a thousand feet long and no inside guard rails in the center. About the 10th of October a car was derailed and ran about 400 ft. before it climbed the outer rail and fell with several other cars to the ground.

Yours very truly,

H. H. Cheatham.

Bainbridge, Ga., Nov. 19, 1906.

Some Pennsylvania Railroad Bridges Which Have Inside Guard Rails.

Sir: In the testimony before the coroner's jury which investigated the Atlantic City drawbridge disaster, prominent engineering officials of the Pennsylvania Railroad testified under oath that inside guard rails were dangerous and should not be used on bridges. It is interesting, in connection with this testimony, to note the fact, which happens to come within the writer's personal knowledge, that two important bridges on the Pennsylvania R. R., Schuylkill Valley Division, are provided with inside guard rails. One of them is the bridge at Manayunk, which is located at the foot of a sharp grade and has a reverse curve on it. Another bridge with inside guard rails is the one over the Schuylkill River at Phoenixville; the bridge is nearly a thousand feet in length, and the track is about 60 ft. above the water. As to whether inside guard rails are a safeguard on bridges or not, it is worth putting on record that on this Phoenixville bridge, about a year ago, a passenger train was derailed while crossing the bridge. Fortunately it was going at slow speed and the inside guard rail held the wheels in line, so there was no damage done.

Yours truly,

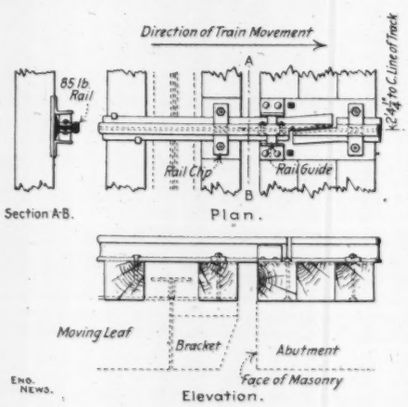
R. H. S.

Philadelphia, Pa., Nov. 23, 1906.

[From another source, we are informed that the new bridge over the Susquehanna River at Havre de Grace, on the Philadelphia, Wilmington & Baltimore Division, one of six which was completed last spring, is provided with inside guard rails.—Ed.]

The Bascule Bridge as a Preventive of Derailments at Drawbridges.

Sir: Referring further to the Atlantic City accident and your interesting discussion in the issue of Nov. 8, 1906, there is no question but that a proper floor, such as you illustrate, would have prevented so fatal a termination of the accident; but it would not have prevented the accident itself. The bascule bridge, on the other hand, would have prevented this particular kind of accident altogether, and, since prevention is better than cure, would not the first step toward a repetition of such disasters be the compulsory use of the bascule?



Rail Joint at Ends of Strauss Bascule Bridge Over Bodine Creek, S. I., New York City.

You are perhaps correct in your statement that you cannot wholly prevent derailments, but it is certain that had the Atlantic City bridge been fixed and not movable, there would have been no more reason for derailment on the bridge than elsewhere. With the draw bridge, there is more reason.

I feel that the fact is being overlooked that this accident occurred, not because there was a b... point, but, because there was a *movable* bridg... the connection between the rails of the fix... able parts was defective. The drawbridge ...sitates the lifting and dropping of the ... junction point independently of the bridge, ...volves independent mechanism and additi... tainty.

I am sending you herewith, a general pl... the rail joint used for the bascule bridge ... now constructing for the B. & O. R. R. Co. ... Creek, Staten Island, and also a detail plan ... plan of the rail-joint is reproduced herewith. ... will notice that this is merely an ordinary ... but the fact that it moves in a vertical pla... quires no operating mechanism, other than ... bridge itself, makes it absolutely safe. The ... moving leaf is firmly secured to the end ... clips. The rail on the fixed part of the brid... ilarly secured to a rail plate. This plate is ... vided with angle guides which engage with ... the moving leaf as it comes down, and ... place after it is down. The bridge itself, ha... tion to its bearing on the foundation, an auto... which prevents the bridge (and therefore the ... lifting under any circumstances.

I believe it would be interesting to compare ... with the ordinary drawbridge rail joint, and ... that its greater simplicity and safety will ... it to you.

Very truly yours,

J. B. Strauss.

Fort Dearborn Bldg., Chicago, Ill., Nov. 20, 1906.

The Computation of Height of Backwater Above Dams.

Sir: In your issue of Nov. 1, 1906, the article entitled "The Computation of the Height of Back Water Above Dams" is very interesting. I have had the problem to solve recently, and I find difficulty in applying the formulas given in that article to my problem, due, I think, to the fact that the river bed with us is very irregular.

I herewith send my solution of our problem because of no other reason than that it may prove interesting to your readers.

Data:

Discharge = Q = 750,000 sec.-ft.

Length of dam = 3,500 ft. at El. 275; 500 ft. at El. 278.

Areas and wet perimeters of sections of river 3,000 ft. apart observed.

Formulas:

For flow over weirs, $Q = CLH^2$ in which C is taken as 3.7.

For flow of streams, Chezy formula, $V = C\sqrt{RS}$ in which C is taken as 55.

By computation the height over the dam is found to be 13.90, which, added to the height of the crest of the dam, gives an elevation of 288.90. The remainder of the solution is given on the accompanying table below.

Respectfully yours,

J. Hayward Harlow, Assoc. M. Am. Soc. C. E.

Darlington, Md., Nov. 9, 1906.

The Effect of Continuity on the Design of Reinforced-Concrete Beams and Slabs.

Sir: Allow me some remarks in regard to the proposals of Mr. John Stephen Sewell in Engineering News of Oct. 25. This question, how to calculate continuous slabs, is nearly as old as reinforced concrete steel in use. It is to be solved, I think, not only by theoretical, but also by practical consideration. I often wondered about the way which seems to be usual in this country: to care little about the moments over supports and to figure only the center of the spans, although this consumes more steel than otherwise would be needed. In my own practice I always distinguish different cases. For solid concrete slabs firmly fixed in stone walls or in heavy concrete-steel beams I use the moment $w\,l^2/12$ for the ends, $w\,l^2/24$ for center of span, except for the roof and top floor of any building. At the same time, in proportion to the greater moment at the ends, the slab is provided with

TABLE SHOWING RESULTS OF COMPUTATION FOR HEIGHT OF BACKWATER ABOVE DAM.

1 Section No.	2 Area of section below el. 285	3 a Area of section below el. in col. 4	4 Elevation of water line	5 V Velocity at section = 750,000 / a	6 w Wet perimeter at el. in col. 4	7 R Hydraulic radius a / w = col. 3 / col. 6	8 S Slope S = V² / C² R; V = col. 5, R = col. 7, C = 55	9 D Distance to next Section	10 Rise = S × D	11 Elevation at next section = col. 4 + col. 10
1	215,080	232,880	288.90	3.22	4,680	49.7	.000068	3,000	0.20	289.10
2	199,760	218,700	289.10	3.43	4,720	46.3	.000084	3,000	0.25	289.35
3	152,000	167,350	289.35	4.48	3,680	45.4	.000146	3,000	0.44	289.79
4	110,800	126,850	289.79	5.91	3,575	35.5	.000325	3,000	0.97	290.76
5	91,840	111,140	290.76	6.74	3,500	31.7	.000473	3,000	1.42	292.18
6	127,520	162,200	292.18	4.62	4,910	33.0	.000213	3,000	0.63	292.81
7	129,120	166,045	292.81	4.51	5,100	32.5	.000206	3,000	0.62	293.43
8	107,920	149,890	293.43	5.00	5,300	28.2	.000291	3,000	0.87	294.30
9	73,520	117,475	294.30	6.38	5,020	23.4	.000575	3,000	1.72	296.02
10	.....	.....	296.02	....	.....	....	.....	.....	....	.....

short brackets at the supports, so that the depth at the end is about three-halves the average depth; the brackets have to be short enough to neither trouble the view nor make the work too expensive. This method of design has proved itself both in several years' use and in rigorous test that it demands good work.

Continuous slabs without safely fixed supports may at least be considered like ordinary continuous beams, the greatest moment of which, with respect to the possible unfavorable distribution of loads over the different openings may for live load reach about $w l^2/9$ over the supports, $w l^2/13$ at center of span; and for dead load about $w l^2/11$ over the support and $w l^2/22$ in center of span (assuming a long row of panels of nearly equal span). For the end panels fixed only on one end the corresponding moments are about $w l^2/8$ over support and $w l^2/14$ at center for the live load, and about $w l^2/9$ and $w l^2/13$ for dead load. It is easily to be seen that the value of the denominator depends upon the proportion of live load and dead load. The well-informed designer therefore must not rigidly stand on the same value for all designs, but adapt the calculation to the individual case. For instance: Normal slabs, live load not more than twice the dead load, assumed good work and correct design, with short end brackets, $M^1 = w l^2/12$, $M = w l^2/24$; for relatively great live loads $M^1 = w l^2/12$, $L = w l^2/16$; for factories with shaking single loads (heavy engines) and for any solid slab built in without safe superintendence and working, $M^1 = w l^2/12$, $M = w l^2/12$; for relatively deep floor constructions consisting of different materials (e. g., tile floors), $M^1 = w l^2/20$, $M = w l^2/10$, may be sufficient.

O. Gottschalk.

Chicago, Ill., Oct. 28, 1906.

Sir: In your issue of Oct. 25, Capt. J. S. Sewell brought up a very important point with regard to the proper design of continuous reinforced concrete beams and girders. Nearly two years ago the writer arrived at exactly the same conclusion as that reached by Capt. Sewell, that W l/12 should be used for both center of member and at supports, in determining resisting moments. As far as possible, the writer makes use of cantilever construction in all design work; first, because it is far superior to that in which the rods are placed at the bottoms of members when considered from a fire-protection point of view; second, because maximum shear occurs with maximum bending moment and they can be more readily cared for together than separately, especially if beams of varying cross-section are used; third, because maximum shear occurs at centers of rods instead of near ends, thereby largely doing away with the end anchorage which is often so important. And doubtless there are other reasons.

The great trouble with making free use of this method of design is in securing proper arrangements at wall ends of members.

In one building the device was resorted to of making the wall beams of practically two members each, both properly supported and anchored so that the weight of the whole side of the building was available to resist the upward tendency of the end of the floor beams in question (Fig. 1).

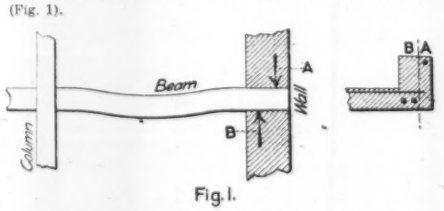


Fig. 1.

Of course a doubly strong fulcrum beam was necessary and the combination had to be carefully investigated as to torsional resistance as well. In the case in question, the above-described solution was found more economical than to use the heavier bottom beam reinforcement which would be required if the beams were considerd as fixed at one end and simply supported at the other.

Prof. Mörsch, of the Zürich Polytechnikum, in "Der Eisenbetonbau," gives tables and curves of the maximum possible positive and negative moments at all points along continuous beams over different numbers of spans up to five, but computed for freely supported ends, and hinged supports at intermediate points. Under such assumptions the maximum possible moments over points of support are very close to W l/8 in all cases, and W l/10 maximum at certain intermediate points. But Prof. Mörsch admitted to the writer that the assumptions were extreme and that W l/12 would probably cover most contingencies without danger.

Of course with the concentrated loads which beams grow into girders, larger moments are possible, and at the present time the writer is making quite an extended study of the subject, including the resisting moment exerted by the resistance to torsion of the beams and girders, and to bending of columns.

While it is possible, with hinged supports, to find both positive and negative moments at all points at different times, under varying loadings (and theoretically such moments require, to resist them, rods both top and bottom throughout the full length of the structure), yet the ever-present dead load often changes the possible variation of moments. Taking all things into consideration, the method proposed by Capt. Sewell for determining the lengths of top rods is as good as any.

The writer, making use as he does almost entirely of graphics, draws a regular moment diagram for assumed loading (this diagram is a parabola, of course, in most cases), draws two closing lines at the third-points of the depth of the curve, Fig. 2, and with a new scale measures the required moment at different points. This new scale is so selected that the maximum moments equal w l/12 in each case, as above described.

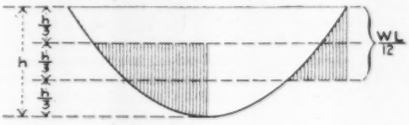


Fig. 2.

The advantage of the graphical method is in the possibility of superposing resisting moment diagrams directly upon external bending moment diagrams (or of preparing the former from and directly upon the latter) and thus securing lengths of rods, points of bend, etc., with ease and no danger of deficiency of reinforcement at some points. Errors of the latter kind the writer has often discovered in checking by this method designs prepared by engineers who depended solely on numerical analysis.

The writer's method gives results practically the same as those obtained by Capt. Sewell, and at the same time conforms very closely to the assumptions made by Prof. Mörsch.

Yours truly,

E. P. Goodrich.

New York, N. Y., Oct. 31, 1906.

THE WORK OF ENGINEERING-CONTRACTING FIRMS.

A development in engineering-contracting work which has been very marked within the past few years is the organization of firms which undertake both the engineering and construction features of large works, designing and building the structures or plants for their clients. A paper on the scope and work of firms of this class was read before the Western Society of Engineers, at Chicago, on Nov. 16, by Mr. George A. Damon, Managing Engineer of the Arnold Co., of Chicago, which is a firm of this particular class, and some of the works of which have been described in our columns. We give below some extracts from this paper, and it will be noted that Mr. Damon favors the "cost plus a percentage" system of payment where the design and construction are both undertaken by the contracting firm, and the "cost plus a fixed sum" system of payment where the firm merely does the construction work according to plans prepared by the client's engineer. An article on different systems of payment for contract work, in which the preference was given to the "cost plus a fixed sum" system, by Mr. Frank B. Gilbreth, was given in our issue of Oct. 18.

One prominent element of modern industrial life is "bigness," and another is "efficiency," which latter may be taken as the key word to business life and engineering practice. These two elements have brought about a condition in which we have the necessity for a technical organization ready to produce large results in an effective way. This opens the field of operation for the creative and constructive abilities of the "engineer-constructor," which is an organization, and not an individual. It makes possible the most effective combination of technical theory with practical experience, and provides for the use of "team work" in connection with the designing and building of properties. Whatever the proposition may be, the engineer-constructor should be prepared to carry it through from beginning to end without technical assistance from outside the organization. To be most effective, such an organization should have at its command the technical knowledge and experience of the past; the ability to analyze situations, and discover the truth from conflicting testimony; the imagination to conceive unprecedented results and courage to overcome obstacles; the ambition to improve existing systems, and the honesty to spend money without favor or graft; and finally loyalty to itself and to its client, which will protect in every way the interests of all concerned. Such an organization substitutes for the isolated efforts of one or more individuals an effective combination of the aggregate abilities of a number of experts. Besides engineers of various branches or specialties there will be an industrial expert, statistician, purchasing agent, construction superintendent, operating engineer, and accountant.

To show the possibilities of such an organization, let us take, for instance, the design and construction of a steam railroad locomotive repair shop, involving the expenditure of from two to three million dollars. The selection of men with their chief duties will be as follows:

1. Industrial Expert.—A, Designing layout of shops; B, Planning method of handling work; C, Arrangement of tool and transportation equipment.
2. Electrical Engineer.—A, Providing power and lighting equipment; B, Laying out transmission systems; C, Planning telephone and signal systems.
3. Mechanical Engineer.—A, Design of power plant; B, Plan of heating and ventilating; C, Laying out air, gas and steam systems.
4. Structural Engineer.—A, Building foundations; B, Designing steel structures; C, In charge of reinforced concrete construction.
5. Architect.—A, Designing building superstructure; B, Choice of fixtures; C, Laying out landscape work.
6. Civil Engineer.—A, Directing grading; B, Testing of soil; C, Construction of tracks.
7. Sanitary Engineer.—A, Design of sewerage system; B, Construction of water-works; C, Choice of plumbing.
8. Purchasing Agent.—A, Selecting markets for material; B, Checking bills of material; C, Arranging for delivery of material.
9. Constructing Superintendent.—A, Organization of construction force; B, Consideration of time element in construction; C, Settling labor difficulties arising in connection with construction work.
10. Operating Engineer.—A, Consideration of economies in operation; B, Securing reliability in operation; C, Insuring effectiveness in operation.
11. Accounting Department.—A, Keeping pay-rolls; B, Making record of costs; C, Preparing progress reports.

In purchasing, the engineer-constructor should find some advantage over an occasional buyer. He is in the market constantly, is favorably known by the manufacturers of standard equipment, and buys apparatus delivered f. o. b. cars, doing all erection work as far as possible with his own experts, and calling on the factory for assistance only when necessary. There should be the greatest unity between the engineering, the purchasing and the construction departments. It is always better to have the construction superintendent in the office while preliminary decisions are being made and bills of material are being prepared.

Most of the work of one of these engineer-constructor firms is done on the basis of "cost plus a percentage," that is, the work is done at actual cost, and then the engineer-constructor gets a percentage fee for his services. Such a fee is usually 3% for plans and specifications, and 10% for purchasing, inspecting, constructing, erecting and testing the necessary buildings, structures and equipment. By such an arrangement the client or purchaser is relieved of the necessity of organizing a technical force of his own, or of employing a number of individual specialists. If the actual construction work is turned over to the engineer-constructor, then the client is relieved of the inconvenience of obtaining proposals and awarding contracts to a large number of separate contractors, with the attendant delays, conflicts and "extras," which even the closest supervision will hardly avoid.

The difference between the "cost plus a percentage" and the "cost plus a fixed sum" plans is not generally understood. If an engineer-constructor is thoroughly trained in drawing plans, has sufficient actual experience to make a reliable estimate, is absolutely honest in all things, and has complete control of a competent construction organization, then the "cost plus a percentage" arrangement is the better; but if the work is planned by an engineer and architect, and the actual building work is turned over to a separate construction organization, thus maintaining the old relationship of engineer and contractor, then the "cost plus a fixed sum" plan, no doubt, has advantage. The "percentage" plans express a shade more of confidence between the client and the builder than the "fixed sum" basis.

REPORT OF THE APPRENTICESHIP COMMITTEE OF THE NATIONAL MACHINE TOOL BUILDERS' ASSOCIATION.*

In order to make a thorough analysis of the apprenticeship systems now in use in the United States, the Apprenticeship Committee of the National Machine Tool Builders' Association addressed 100 representative manufacturing concerns of the country, inclosing a list of questions, bearing on the subject, to be answered. Replies were received from 51 machine-tool builders and 26 other concerns, such as electrical manufacturers, engine builders, automobile manufacturers, etc. These replies indicated that 66% of the concerns located in New England, 55% of those in the Middle Atlantic States and 62% of those in the Central Western States employ apprentices. Also that a majority of such concerns enter into a formal agreement to properly instruct the apprentices during a stated period of service. An interesting point brought out by the investigation of the committee is that al-

*Condensed from the "American Machinist."

though the apprentice in certain cases takes longer to perform a given duty, nevertheless, the lower labor cost at which he is working is sufficient to give him an advantage over the journeyman in total cost of production. Furthermore, it developed that apprentices do not always require more time than a journeyman to do a given operation with precision.

A list of the questions submitted to the manufacturing companies by the committee follows, and each question is in turn followed by a synopsis of the replies received to that question. These synopsises were compiled by the committee after carefully considering all answers received and show the prevailing manner of employing apprentices.

Q. 1. Do you indenture apprentices to the machinist trade?

A. The majority of machine-tool builders have established apprenticeship systems, which are in more or less satisfactory operation. A smaller percentage of the allied trades have some system, but one large industry, the automobile manufacturers, with one exception, employs no apprentices.

Q. 2. Have such apprentices proven satisfactory from a commercial standpoint?

A. Apprentices have proven satisfactory from a commercial standpoint.

Q. 3. What is the approximate ratio between the number of apprentices and machinists employed?

A. The approximate ratio between the number of apprentices and journeymen employed by the machine-tool builders is about 18%, whereas the allied trades do not average over 13%.

Q. 4. Have graduate apprentices of your works been advanced to positions of authority while in your employ?

A. Graduate apprentices have been advanced to positions of authority in many shops. Some concerns state that their foremen come almost entirely from this class.

Q. 5. Is difficulty experienced in securing a sufficient number of intelligent apprentices?

A. All reports indicate that difficulty is experienced in securing a sufficient number of intelligent apprentices. It seems, however, that the questions of wages and time of service have little effect on this question.

Q. 6. Are applicants required to have a specific amount of previous school training?

A. But few concerns require a specific amount of previous school training, the majority requiring a common-school education only.

Q. 7. Are courses of instruction provided for apprentices during their term of service?

A. As a general rule, courses of instruction are not provided for apprentices.

Q. 8. Is attendance on these courses compulsory?

A. Those who do provide such a course make attendance compulsory.

Q. 9. Are apprentices under the charge of a special instructor while employed in the works?

A. Apprentices are usually under the direct charge of the foreman of the department.

Q. 10. Are apprentices permitted to work on either the premium or piece-work system?

A. About 50% of the concerns employing apprentices permit them to work under either the premium or piece-work system.

Q. 11. Are small tools provided for their use free of charge?

A. Thirty-three per cent. provide small tools free of charge.

Q. 12. Are inducements of either shorter time or increased pay offered to technical graduates to learn the machinist trade?

A. Thirty-three per cent. offer special inducements to technical graduates, but state that they find it difficult to secure them.

Q. 13. Do you indenture apprentices to the various branches of the trade, such as lathe work, planer work, etc?

A. Twelve per cent. state that apprentices are taken to the various branches of the machinist trade.

Q. 14. Is any provision made for these special apprentices to become regular apprentices, should they desire, after having completed their special apprenticeship?

A. But a small percentage of the above make provision for special apprentices to become regular apprentices after having completed their special course.

The committee then make the following recommendations regarding apprenticeship courses.

Having an insufficient number of skilled workmen, we can only increase this supply by teaching the machinist trade to an increased number of boys. Finding difficulty in securing a sufficent number of boys for this purpose, we must offer inducements which will attract them to the trade.

We should therefore suggest: (1) The drafting of uniform apprenticeship contracts, covering both regular and special apprentices, same to be binding both to the employer and employee, the former to be obliged to properly instruct the latter in the branch or branches of the trade specified in the contract. We also suggest that the articles of indenture provide sufficient guarantee on the part of the apprentice for the satisfactory completion of his time of service, the wages paid to be optional with the individual employer. We believe this point is essential, as it is apparent from our investigation that apprentice wages vary in different sections of the country. It would seem advisable, however, to have a uniform term of service in all cases to be based on the time found necessary, by previous experience, to properly teach the branch or branches of the trade specified in the contract.

(2) The number of apprentices employed in any shop should be limited only by the ability of the employer to properly instruct them.

(3) Graduate apprentices should be advanced wherever possible, and preference given them in making promotions.

(4) Special apprentices or those indentured to one branch of the trade only, should have a common-school education, and regular apprentices, or those indentured to the full trade, to have at least a grammar-school education.

(5) Courses of instruction for apprentices during their term of service should be provided, where practicable, and attendance upon such courses, where provided, be made compulsory. High-school and technical graduates should be exempt from special study during their term of service. A special instructor should be provided where practicable.

(6) Apprentices should be permitted to work on the premium or piece-work systems. All small tools should be provided for their use free of charge, these to be furnished new on completion of their trial period, and presented to them on the satisfactory completion of their term of apprenticeship. These tools should be inspected by an authorized official at stated intervals, and their condition reported. These reports would be valuable in determining the interest and ability of the apprentices.

(7) Technical graduates should be encouraged to indenture themselves to the trade by offering higher wages and shorter period of service. Influence should be brought to bear upon those in authority at the technical schools to impress upon them the demand in the machine-tool business for men having a technical education, and willing to learn the practical side of the business.

(8) Indenture apprentices to the various branches of the machinist trade, making the term of service short and wages relatively high. Offer bonus or reward for the satisfactory completion of apprenticeship.

(9) Offer an opportunity for special apprentices to become regular apprentices, should they so desire on the completion of their special apprenticeship, the time so served applying on the regular apprenticeship course in proportion as may be thought advisable.

(10) Finally, issue a diploma, bearing the seal of the National Machine-Tool Builders' Association, to both regular and special apprentices, stating clearly the work accomplished during term of service.

THE COST OF CLEARING AND GRUBBING A RESERVOIR SITE.*

By Julian Griggs,† M. Am. Soc. C. E.

In this paper it will be the purpose of the writer to give with some detail the cost of clearing and grubbing the site of the reservoir formed by the construction of the Scioto River storage dam for the municipal water supply for the city of Columbus, O.

The work to be described was but a small portion of the total expenditure of about $700,000 by the city for the dam and works appurtenant thereto, but the failure of the writer, after a somewhat extended search of engineering literature, to find descriptions of this portion of similar undertakings has led to the hope that a paper on the cost of clearing and grubbing a reservoir site will prove a welcome, though slight, contribution to the subject of water supply engineering.

Cases of complete soil removed, as in the Wachusett reservoir for the Boston Metropolitan Water System, are not unknown. Perhaps, however, it has never before covered so large an area and been done with quite the degree of thoroughness which there obtained, but wherever done it is for the engineer mainly a question of estimating the cost of excavating and hauling a given quantity of earth, while the clearing and grubbing become a secondary matter, as tending only to increase slightly the cost per cubic yard for excavating and removing the earth to a point outside of the reservoir.

In the Columbus case the usual conditions were reversed, for the reason that the Scioto River is normally a muddy, western silt-bearing stream, with a drainage area of 1,032 sq. miles above the dam and a flood discharge approximating a maximum of 50,000 cu. ft. per sec. The relation of reservoir capacity to maximum discharge is such that the reservoir at maximum flood flow would fill and empty 20 times in 24 hours. It is therefore expected that silt in material amounts will be deposited in the reservoir at every considerable rise of the river, and under these conditions it was not deemed necessary to remove any of the surface soil except to a very limited extent around former human [habitations] within the submerged area; but responsive [to re]quirements of the Ohio state board of health, [vegeta]ble growths were cut down even with the gr[ound,] then gathered into heaps and burned, while [stumps] and roots of all trees and shrubs 1 in. or mo[re in] eter were grubbed to a depth of 1 ft. below [surface] and similarly gathered and burned.

The reservoir is unique in its way by being [usually] long (5.8 miles) for its width, which varies b[etween] and 820 ft. and averages only 504 ft. at the [200-ft.] face with reservoir full. The river in anc[ient times] wore a gorge in the limestone rock of the Upp[er Silur]berg formation, some 90 ft. below the general [surface,] a width of from 600 to 800 ft., and in more r[ecent] has filled it in again with rich alluvial depo[sits to a] depth of about 18 ft., through which the prese[nt stream,] with a descent of 5 or 6 ft. per mile, has cut [a slightly] meandering channel 10 to 12 ft. in depth and ab[out 100 ft.] in width.

In places on either side of the gorge, verti[cal bluffs] 20 to 30 ft. high for perhaps a total length w[ithin the] reservoir limits of two miles still remain, but, [generally] speaking, the rocks forming the sides of the gor[ge have] crumbled and now appear as steeply sloping [hillsides,] too rugged for cultivation and for the most pa[rt well cov]ered with trees and shrubs.

From the above description it will be seen [that the] reservoir formed by the dam, which has a heigh[t of 32] ft. from its apron to its rollway, will fill the gor[ge at its] lower or south end, 720 ft. in width, and only th[e present] river channel, 200 ft. in width at its upper or northern end. The greatest depth of water in the reservoir is 35 ft. and the mean depth is 14 ft., or 40% of the maximum. The area of the river at ordinary low water within the reservoir was 125.7 acres, while the water surface of the reservoir at the elevation of the rollway is 351 acres.

A portion of the bottom land for an aggregate area of about 36 acres had been cultivated before it was purchased by the city, but the remainder was thickly covered with a growth of trees and shrubs common to the forests or groves of this locality, and consisted mainly of elm, oak, beech, hickory, maple, buckeye, locust and sycamore, the latter especially growing to large proportions, some of them being 5 ft. in diameter. The shrubs were mostly osage orange, willow and pawpaw and smaller growths of the trees above-mentioned. The bottom lands were very fertile, and everywhere, in addition to the trees, supported a rank growth of weeds, among which horse cane (Ambrosia trifidia) predominated, growing to a height of 8 to 13 ft.

The area to be cleared and grubbed consisted then of two strips of land, one on each side of the river, together with a number of densely wooded islands, aggregating a total of 255.6 acres, 5.2 acres being below the site of the dam, cleared but not grubbed. The outside boundary of the clearing was contour 75 ft., which was 2 ft. above the crest of the rollway of the dam.

The base of levels was city datum on an assumed plane 100 ft. below the water table of the Ohio state capitol.

The dam, and the beginning or south end of the reservoir, is 7½ miles northwest from the center of the city and is now reached by trolley cars with an hourly service.

Bids for the grubbing and clearing were received by the board of public service on May 11, 1904, on an estimated area of 270 acres, as follows:

Name of Bidder.	Rate per acre.	Total bid.
Hoover & Kinnear	$ 70.00	$18,900
John H. Clutter	149.50	40,365
Fisher & Knight	155.00	41,850

The proposal of Messrs. Hoover & Kinnear of Columbus, O., was accepted and a contract with them was executed June 6. Work was begun on June 14, 1904, and carried on continuously until completed, April 5, 1905.

The method adopted by the contractors in doing their work was divided into three and at times into four operations.

(1) A gang called the "Trimming Gang," consisting of from 4 to 20 laborers, equipped with axes and grubbing hoes, under the direction of a foreman, trimmed the limbs from the larger trees as high as they could reach, cut off the smaller trees about 2 ft. above the ground, grubbed out the brush and roots and gathered into piles everything that could be burned.

(2) The trimming gang was followed by a "Pulling Gang," composed of from 6 to 12 laborers, a team of horses and a stump puller. Their work was to pull up the trees and stumps. Some of the time the same gang and at other times a third gang (third operation) cut the trees and stumps into pieces that could be readily handled, grubbed out the exposed roots and piled the whole for burning, excepting such portion of trees as were saved for saw logs.

When the work began it was thought necessary to partly season and dry the brush and wood by several weeks exposure before burning, but during the winter it was found practicable to burn everything as soon as it was cut and piled.

*A paper read before the annual convention of the American Society of Municipal Improvements, Birmingham, Ala., October, 1906.

†Consulting Engineer, Columbus, O.

The stump puller used was of the type known as the "Hercules Stump Puller," and consisted of a vertical iron windlass, operated by a team of horses. The bed to which the end of the spindle of the drum was secured was formed of two pieces of oak timber each 10 x 10 ins. x 16 ft. in length, framed into a cross with equal arms. The drum was 13 ins. in diameter and 2 ft. in length. The spindle above the top of the drum was secured by four legs made of iron pipe, inclined outward at an angle of about 45°. At the lower ends, the legs were united together with an iron strap to prevent spreading, and each was fastened to an arm of the timber bed. To the end of the spindle projecting above the legs was secured one end of an 8 x 8-in. oak timber; to the other end was hitched a pair of horses, making a sweep of 20 ft. radius. Dragging from this sweep, directly back of the team, was a stiff stick, the end upon the ground shod with an iron point, the purpose being to hold the strain made by the sweep when the horses were standing or when taken away. With each machine there were two pieces of ¾-in. wire cable about 100 ft. in length, hooks, grips, blocks, snatch cables and so forth. Four of these machines were in use by the contractors.

In operation the timber bed was buried in the ground, and to make it secure, iron pins were driven into the ground against the sides of the timbers, or the timbers were loaded with stone. The snatch cable was usually fastened around the tree to be pulled, from 10 to 20 ft. above the ground. The cable was usually passed through a snatch block fastened to a tree near the stump puller so as to bring it into a horizontal position as it was wound upon the drum. If the tree was too firmly rooted to be moved when the strain was applied, sometimes a part of the roots were cut, but usually it was the practice to explode a charge of dynamite among the roots without releasing the strain from the stump puller. Stumps, of which there were large numbers, were harder to pull than the trees, and most of them had to be broken up with dynamite and taken out in pieces. Many of the trees had roots at a considerable distance below the surface of the ground, probably due to the gradual accumulation of earth above them since the trees began to grow. Large quantities of dynamite were used. It is said that sixty sticks were exploded in removing one

Detailed Cost of Cleaning and Grubbing Reservoir Site, Columbus, Ohio.

Item	Days	Rate	Total	Per cent. of cost
Superintendent	255	$4.16⅔	$1,063	2.6
Time keepers	255	1.75	446	1.1
Foremen	1,030	2.50	3,325	8.2
Foremen	205	2.00	410	1.0
Carpenter	54	2.00	108	.3
Dynamite men	435	1.75	761	1.9
Laborers	14,491	1.50	21,737	53.3
Single horse	222	1.50	333	.8
Two horse team	847	3.50	2,964	7.3
Dynamite ..... 68,000 lbs		.11½	7,820	19.1
Machinery and repairs..	.....	....	1,800	4.4
Total			$40,767	100

Cost per acre, $159.50.

stump. After the trees had been pulled and burned the ground was all gone over during the months of March and April, all loose pieces of wood were picked up, any grubbing previously overlooked was done and the grass and weeds burned.

The common harrow was found to be the best tool for breaking down and gathering the weeds. It is estimated that 3,000 saw logs were sold by the contractors at $2.50 per 1,000 ft. B.M. and there would have been many more if the trees had not been shattered by exploding dynamite.

The accompanying table of costs is derived from the inspector's daily reports, and is believed to be fairly accurate. Commmon labor was paid $1.50 per day of ten hours and is the largest item of cost, being 53.3% of the total. The next largest item is dynamite, 19.1%, followed by foremen, 8.2%, and horses, 8.1%, machinery, 4.4%; accounting for all but a remainder of 6.9%, which is divided among superintendent, dynamite men, time keepers, blacksmith and carpenter. The cost per acre, therefore, for the work done was $159.50.

The final estimate, given May 17, 1905, was for 255.6 acres at $70 = $17,892.

In addition to the above there was paid to the contractors $1,685 for doing work outside of the contract, the following amounts being cost to contractors with 15% added for use of tools and profits:

Building guard fences along public highways at dangerous places	$230
Removing trees and stumps from the river.....	284
Clearing the city's land above contour 75 ft.....	1,158
Miscellaneous work	13
Total	$1,685

The season was unusually favorable for the prosecution of the work as there were no delays and very little additional expense by reason of high water.

The accompanying table indicates that the contractors lost a comparatively large sum of money in the execution of their contract, but they never showed any disposition to slight the work or endeavored in any way to diminish to their advantage the amount thereof, neither did they permit the work to drag along, as not infrequently happens under such conditions, but prosecuted it with energy and completed the same within the time limits of their contract obligation, for which honest endeavor they are entitled to and should receive great credit.

Prior to the beginning of the work by the contractors a line of levels was run on each side of the river and stakes set to indicate on the ground the position of contour 75 ft. These stakes were set as often as there was a change in the direction of the contour and were from 50 to 400 ft. apart. As an aid to finding them again they were numbered consecutively from the dam. To check the work the two lines of levels were connected at intervals of about a mile.

After the land had been cleared, survey lines were run one on each side of the valley near contour 5 ft., and the contour stakes previously placed were located by right and left measurements. Survey lines were also run on each side of the river, from which the shore line of the stream was similarly located, and to check the work all of the survey lines were tied together at intervals of about a mile. Contour 73 ft. was also run and a careful observation made to be sure that no grubbing had been omitted below that elevation. All survey lines were then platted and the areas having been computed by latitudes and departures were checked by planimeter measurement on the plats, which were made to a scale of one inch equal to one hundred feet.

In May, 1905, the site of the reservoir was practically cleared of all vegetation and ready to be filled, which by the requirement of Contract No. 1 for the dam was to have begun by the middle of that month. The work on Contract No. 1 had not been prosecuted at the rate stipulated in the specifications and was further delayed during the summer, so that by the middle of August the whole reservoir site was covered with a luxuriant growth of weeds, some of which measured 13 ft. in height, and it became necessary to remove them before the reservoir could be filled.

An unsuccessful effort had been made the previous season to burn the dead weeds as they stood upon the ground. Neither would they burn when broken down. The city therefore engaged a foreman with a gang of seven Italian laborers to cut the weeds and after they had sun dried, to gather into piles and burn them. This work began Aug. 21, 1905, and was continued until water was running over the completed crest of the dam on Dec. 6, 1905. Where possible a horse rake was used in gathering the weeds, but where the surface could not be raked, manure forks were used for this purpose.

Shortly prior to Dec. 6 a day was fixed for dedicating the dam and it was then determined to fill the reservoir as speedily as possible. A large gang of extra men with tents and supplies was sent to the reservoir to rapidly complete the weed cutting and cleaning then being prosecuted by the city foreman and the small gang.

The cost to the city of the work so done between Aug. 21 and Dec. 6, 1905, was $1,969, divided into labor, tools and supplies, as follows:

Item	Labor	Tools & supplies	Total
Small gang	$1,210	$44	$1,254
Large gang	429	286	715
Total	$1,639	$330	$1,969

It will be seen, then, for clearing and grubbing a reservoir site under the conditions which obtained in the work herein described, and neglecting the general expense of the contractors, the cost with common labor at 15 cts. per hr. may be reckoned at $159.50 per acre, to which there may be added for extra work required a further cost of $6.73 per acre. And if the reservoir is allowed to grow up with weeds and needs to be again cleaned the added cost will be $7.86 per acre, or a total for all work done of $174.09 per acre for the area covered, in which is included none of the cost of engineering and inspection.

For the very efficient supervision of the execution of this contract and the carefully prepared cost records and descriptions as stated in the foregoing paper, I am indebted to Mr. F. B. Edwards, resident engineer in charge of the work under the direction of the writer as chief engineer of the Board of Public Service of the City of Columbus, Ohio.

YELLOW HEAD PASS has been chosen by the Grand Trunk Pacific Ry. Co. in its proposed route from Edmonton westward through the Rockies to the intended terminus near Port Simpson. It has been understood for some time that the Canadian Northern Ry. Co.'s extension to the Pacific Coast would traverse the Yellow Head Pass, and at the present time these rival companies are at work locating their lines through the same Pass. According to engineers familiar with the locality, the valley is wide enough to accommodate a half dozen roads, so there appears to be no valid reason why the two railways should not take advantage of this natural highway through the mountains.

THE PRESIDENT'S VISIT TO THE PANAMA CANAL WORK.

There was quiet over Colon,
  There was peace in Panama,
(Where the role of "Sleeping Beauty"
  Is performed with great éclat;)
All the dredges were reposing
  With their noses in the dirt;
Every engineer was dozing
  In his trousers and his shirt,
And the darky with the shovel
  Sweetly slumbered in the mud
With his faithful mule beside him,
  Gently chewing of its cud.
Poultney Bigelow was forgotten,
  Brother Taft was far away;
All the Isthmus took its pleasure
  In a dreamy holiday—
When along the throbbing wire
  The electric message ran:
"He is coming! He is coming!
  Better hustle while you can!"
Every dredge in sudden hunger
  Took a double chew of soil;
Every engineer grew vocal
  With the blasphemies of toil;
Every darky swung the shovel
  Just as fast as he could pitch;
Every mule developed interest
  In the progress of the ditch;
Every brush and broom in Colon
  Set to work to clean the place;
Every mammy in Culebra
  Scrubbed her pickaninny's face,
And the gravel fell in showers,
  And the mud in yellow rain,
Till the atmosphere resembled
  A political campaign;
Every industry and business
  Took a mighty sudden spurt,
For when Teddy comes a-calling,
  Then it's best to shovel dirt.

Arthur Guiterman in "New York Times."—

COLLAPSE OF A REINFORCED CONCRETE BUILDING under construction at Kodak Park, Rochester, N. Y., for the Eastman Kodak Co., occurred on Nov. 21. From an authoritative source we have received the following concerning the collapse:

This building was 134 ft. x 109 ft., two stories high, and consisted of reinforced concrete frame, tile floors and brick veneer walls. The contractor for the reinforced concrete and the floors of this building, as well as for five others of the same type being built for this company, is the Concrete Steel & Tile Construction Co., of Detroit, Mich. The building is nearing completion and the workmen were removing the centering and shoring from a section of the roof near the northeast corner when it collapsed, apparently without warning, causing the instant death of two of the workmen. Two others were injured so seriously that they have since died and fifteen others were injured, but not so seriously but that it is expected that they will recover.

The section of the building which collapsed, about 53 x 88½ ft., had been poured about four weeks before any of the centering was removed and had been examined the day before the accident by the foreman for the contractors for the concrete construction and pronounced in condition for removing the supports.

The building has been carefully examined by the inspectors of the Fire Marshal's office of the city of Rochester and also by the County Engineer, who act as experts for the Coroner, who is investigating the disaster.

FOR WATER SUPPLY AND BRIDGE TERMINALS the Board of Estimate of New York City on Nov. 23 authorized the expenditure of $15,000,000. Of this $10,000,000 is to be utilized by the Board of Water Supply for the contract to be awarded on Dec. 4 for the construction of the first 11 miles of new aqueduct which will be built in connection with the Catskill water project. For the purchase of land approaches to the new Manhattan Bridge, $5,000,000 was appropriated. The Board also ordered title taken within 30 days or by Dec. 24, of enough land adjacent to the Brooklyn Bridge on the Manhattan side for an improved bridge terminal, work on which should commence within 90 days. Among the property needed for this last mentioned project is the Staats Zeitung Building. Tenants of the other property are business people, saloon and restaurant keepers, small factory men, and hotel owners. At this meeting of the Board, notification was received from the Rapid Transit Commission that it was ready to advertise for bidders for the construction of four new subways covering about 50 miles at a cost of $125,000,000, and to be known respectively as the Fourth Ave. route, the Coney Island route, from the Manhattan Bridge, the Lexington Ave. route, and the Seventh, Eighth and Jerome Ave. route.

A CONFERENCE OF MEMBERS OF THE U. S. Reclamation Service will be held in connection with the National Drainage Congress at Oklahoma City, Okla., Dec. 5 to 7. The Drainage Congress—the first of its kind—is to be held in the hopes of doing ultimately for

drainage what has been done for irrigation through organized effort and educational work. The presence of the Reclamation Service engineers at the Congress may be expected to aid materially in the initial stages of the work which the Congress proposes. These engineers, and also those in the Topographical Department of the U. S. Geological Survey, are many of them quite familiar with drainage needs and possibilities in various parts of the country.

A COLLISION OF OCEAN LINERS near Cherbourg, France, Nov. 21, badly damaged the North German Lloyd steamship "Kaiser Wilhelm der Grosse" and the British Royal Mail steamship "Orinoco," while 13 persons were killed and 14 injured. The accident occurred just after the pilot had left the "Kaiser," which was leaving Cherbourg for New York. The "Orinoco" was entering the harbor. Both boats were so badly damaged that the passengers and mail were transferred to other steamers and the boats sent to dry-dock for repairs. It is estimated that the repairs to the "Kaiser" will amount to $200,000, a large hole being stove in her starboard bow where the "Orinoco" struck her. The accident is said to have been due to the "Kaiser" ignoring the signals of the "Orinoco" and trying to cross her bow.

THE WRECKING OF THE SUBMARINE "LUTIN" of the French navy on Oct. 16 has been explained by the official commission of inquiry as being due to the failure of the interior bulkhead of a water-ballast compartment while the vessel was below the surface. The intake valve of this compartment was blocked by a pebble, so that the full head of water above the vessel could act against the inner bulkhead.

SPREADING RAILS wrecked the "Oriental Limited" of the Great Northern Ry. near Dohon, N. D., Nov. 22. Three of the train crew were killed and five other persons injured. All of the cars left the rails, while the engine, mail and baggage cars were demolished.

A RUNAWAY FREIGHT TRAIN on the Southern Ry. killed two men at Old Fort, N. C., on Nov. 19. The train was bound east, and on the heavy downgrade of the eastern slope of the mountains west of Old Fort it got out of control and ran wild for eight miles.

A PREMATURE EXPLOSION of giant powder at a lime quarry near Douglas, Ariz., Nov. 15, killed 8 men and injured 8 others. A large quantity of the powder had been put in place for blasting and one of the men was tamping the holes, when it is supposed a spark struck by the tamping rod ignited the powder and caused the explosion.

AN OBSERVATORY AND NAUTICAL MUSEUM is to be founded at New York City, according to Prof. Charles Lane Poor, of Columbia University. Prof. Poor announced, in an address before the New York Academy of Sciences, that Mr. Frederick G. Bourne, Cornelius Vanderbilt and others would apply to the New York State Legislature and the New York City authorities for a charter and that they would raise an endowment sufficiently large to carry on scientific work, furnish instruments, apparatus and collections for the museum. Besides investigating all problems arising in transportation by water, especially as affecting New York, the institution will establish a bureau for the standardization of nautical instruments, etc. The plans for the various buildings that will be required have been completed, and it is hoped that the city will provide a site for them in Bronx Park and build the museum and observatory, as these will be free to the public, being open several evenings each week for their use and instruction.

THE REBUILDING OF THE CAMPANILE in Venice has been interrupted by serious charges made against the quality of the materials being used in the work. A dispatch of recent date gives news of a report made to the city authorities by an expert called in to report on the materials. This report, it is stated, condemns the brick and cement as being of so poor quality as to lack durability, and recommends that the new work be pulled down again, as far as the foundations.

FIFTY REST AND RECREATION HOUSES for Pennsylvania Railroad employees have been provided on the lines east of Pittsburg and Erie. They are located at freight yards and termini, where train crews are changed, and are furnished with beds, cupboards, lavatories, restaurants, newspapers, periodicals, libraries and games. Some of the houses are also fitted with mechanical appliances for air-brake and injector instruction, and skilled men are on hand to supply the necessary information. About $75,000 has been expended for furniture, and maintenance costs the company $30,000 annually. One of these houses on Filbert St., Philadelphia, cost over $30,000, and the service costs between $400 and $500 a month. Everything in the place is absolutely free to the men. There are 72 beds, 16 couches, 983 lockers, and a circulating library of 1,286 books. The company realizes that anything which provides for the physical welfare of the men, not only benefits them but also the railway in that it receives from the employees better and more loyal service.

PERSONALS.

Mr. S. A. Nichols has been appointed Superintendent of the Missouri & North Arkansas Ry., to succeeed Mr. O. Man, resigned.

Mr. J. A. Green, Acting Chief Engineer of the Montana R. R., has been appointed Chief Engineer, to succeed Mr. F. T. Robertson, deceased. His headquarters are at Helena, Montana.

Mr. George F. Maitland has been appointed Resident Engineer of the Wyoming and Colorado Divisions of the Union Pacific R. R., with headquarters at Cheyenne, Wyo. He succeeds Mr. L. B. Merriam, resigned.

Mr. W. H. Petersen has been appointed Bridge Engineer of the Chicago, Rock Island & Pacific Ry. (not Chicago & Northwestern Ry., as stated in Engineering News of Nov. 22, 1906, p. 554), with office at Chicago, Ill. He succeeds Mr. W. C. Armstrong, resigned to accept service with another company.

Mr. Robert McF. Doble, of Colorado Springs, Colo., formerly of San Francisco, Cal., has been retained by Messrs. Curtis and Hine, General Managers of the recently organized Central Colorado Power Co., as Consulting and Supervising Engineer in the development of their hydro-electric power projects on the Grand River, Colorado.

Mr. A. Baur has opened an office in the Hatchett Building, Miami, Fla., as a consulting and constructing civil engineer. For the last three years Mr. Baur has been in the employ of the Florida East Coast Hotel Co. as Constructing Engineer. While thus employed he has built water-works and sewer systems at Palm Beach and West Palm Beach, Fla., and a water system at Miami, Fla.

Mr. Charles M. Jacobs, M. Am. Soc. C. E., who designed the Pennsylvania Railroad Company's tunnels under the North and East Rivers, New York City, has been retained by the French Government to prepare plans for a tunnel to be built under the Seine River from Rouen to Havre. The tunnel will be about one mile long and arranged for two railway tracks, and it is estimated that it will cost $10,000,000 to $11,000,000.

The following changes have taken place in the personnel of the Reclamation Service: Messrs. Edward H. Bispham, O. P. Morton, Ralph B. Williamson and C. S. Witbeck have been appointed Examiners (classified service) and will be assigned to various reclamation projects in connection with legal work; Mr. Edwin L. Driggs has been appointed Engineering Aid and assigned to duty on Uncompahgre Valley project; Mr. Hugh G. Stokes, Assistant Engineer, employed on Salt River project, Ariz., has resigned from the service.

The following changes have been made in the operating department of the Chicago & Northwestern Ry.: Mr. Stanley M. Braden has been appointed General Superintendent of Lines West of the Missouri River, to succeed Mr. Charles H. Hughes, retired. Mr. W. D. Beck has been appointed Superintendent of the Galena Division, to succeed Mr. Braden. Mr. P. J. O'Brien succeeds Mr. Beck as Superintendent of the Madison Division, while Mr. Fred. H. Hammill succeeds Mr. O'Brien as Superintendent of the Northern Wisconsin Division. Mr. Silas H. Brown has been promoted to Superintendent of the Sioux City Division, to succeed Mr. Hammill, and Mr. E. E. Smith succeeds him as Superintendent of the Northern Iowa Division. Mr. C. E. Andrews has been appointed Superintendent of the Lake Shore Division, with headquarters at Green Bay, Wis.

Obituary.

Walter H. Thorne, a railroad contractor of Baltimore, Md., died at his home on Hillen Road, Nov. 20, of pneumonia, aged 54 years.

Peter Edward Le Fevre, for 25 years Superintendent of the Savannah Steamship Line, died Nov. 19, at his home in New York City, aged 65 years.

Alexander Wood, a civil engineer long employed in the office of the City Engineer of Indianapolis, Ind., died at his home in that city, Nov. 10, aged 84 years.

Henry Wehrum, for many years Consulting Engineer and General Manager of the Lackawanna Iron & Steel Co., died at Buffalo, N. Y., Nov. 23, of apoplexy.

Gen. John H. Bryant, President of the Seattle & International Ry., died at Washington, D. C., Nov. 19, of paralysis. Mr. Bryant was born March 17, 1840, on shipboard. He served in the Civil War and later settled in Richmond, Va., where he established a sumach factory. He established similar factories at Petersburg, Va., and Greensborough, N. C., and operated the Black Heath coal mines of Chesterfield County, Va. At the time of his death he was also President of the Seattle Coal & Iron Co. and of the Gilman Coal Co.

ENGINEERING SOCIETIES.

COMING MEETINGS.

AMERICAN SOCIETY OF REFRIGERATING ENGINEERS.
Dec. 3-4. Annual Meeting at New York City. Secy., W. H. Ross, 258 Broadway, New York, N. Y.

AMERICAN PUBLIC HEALTH ASSOCIATION.
Dec. 3-7. Annual Meeting at Mexico City. Secy., Chas. O. Probst, M. D., Columbus, O.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
Dec. 4-7. Annual Meeting at New York City. Secy., F. R. Hutton, 12 West 31st St., New York, N. Y.

ENGINEERING ASSOCIATION OF THE SOUTH.
Dec. 14-15. Annual Meeting at Atlanta, Ga. Secy., M. Jones, 2 Berry Blk., Nashville, Tenn.

AMERICAN ECONOMIC ASSOCIATION.
Dec. 26-28. Nineteenth Annual Meeting at Providence, R. I. Secy., Mr. Winthrop M. Daniels, Princeton, N. J.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.
Dec. 27-Jan. 2, '07. Annual Meeting at New York City. Secy., L. O. Howard, Cosmos Club, Washington, D. C.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
Jan. 3. Annual Meeting at Pittsburg, Pa. Secy., F. V. McMullin, 410 Pennsylvania Ave., Pittsburg, Pa.

NATIONAL ASSOCIATION OF CEMENT USERS.
Jan. 8-11. Annual Meeting at Chicago, Ill. Secy., W. W. Curtis, 585 Caxton Bldg., Chicago, Ill.

NEW ENGLAND WATER-WORKS ASSOCIATION.
Jan. 9. Annual Meeting at Boston, Mass. Secy., Mr. Willard Kent, Narragansett Pier, R. I.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
Jan. 16-17. Annual Meeting at New York City. Secy., C. W. Hunt, 220 West 57th St., New York.

INDIANA ENGINEERING SOCIETY.
Jan. 17-19. Annual Meeting at Indianapolis. Secy., C. C. Brown, Commercial Club Building, Indianapolis, Ind.

THE ENGINEERS' CLUB OF PHILADELPHIA.
Jan. 19. Annual Meeting at Philadelphia. Secy., Walter Loring Webb, 1122 Girard St., Philadelphia, Pa.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.—The society held its fourteenth annual meeting at 12 West 31st St., New York City, Nov. 22-23. This was the last annual meeting that will be held in their old quarters, as the Secretary announced that the society had secured quarters in the new Engineering Building. The election of officers resulted as follows: President, Mr. Francis T. Bowles; Vice-Presidents, Messrs. D. W. Taylor and W. L. Capps; Secretary and Treasurer, Mr. W. M. J. Baxter.

ENGINEERING ASSOCIATION OF THE SOUTH.—The eighteenth annual meeting of the association will be held at Atlanta, Ga., Dec. 14-15. Headquarters will be at the Kimball Hotel. The first session will be held Friday evening at 8.15 o'clock in the assembly room of the hotel. This meeting will be devoted to the business affairs of the association and to the President's annual address. Saturday will be given over to visiting engineering structures in and near Atlanta, followed in the evening by the annual banquet.

AMERICAN ECONOMIC ASSOCIATION.—The nineteenth annual meeting of the association will be held at Providence, R. I., Dec. 26-28. The hotel headquarters will be at the Narragansett Hotel, Weybosset and Dorrance Sts. Joint sessions will be held with the American Historical Association, the American Political Science Association and the American Sociological Society, as all of these societies hold their annual meetings this year at Providence on these dates. Among the papers to be presented are: "On What Principles Should a Court of Arbitration Proceed in Determining the Rate of Wages," Mr. John B. Clark; "Labor Organization and Labor Politics, 1827-1837," Mr. John R. Commons; "The Government Regulation of Insurance Companies," Mr. Maurice H. Robinson; "Transportation," Mr. Frank H. Dixon. A business session for the election of officers, etc., will be held at 5.30 p. m., Friday, Dec. 28. Secy., Mr. Winthrop M. Daniels, Princeton, N. J.

AMERICAN SOCIETY OF REFRIGERATING ENGINEERS.—The second annual meeting of the society will be held Dec. 3-4 in the Chambers of the American Society of Mechanical Engineers, 12 West 31st St., New York City. At the first session, Monday, Dec. 3, at 9.30 a. m., the reports of committees will be read and general business transacted, after which the President will give his annual address. The other sessions of the convention will be given over to the reading of papers. Tuesday evening a subscription banquet will be given at "The Arena," 39 West 31st St. Among the papers to be presented are: "Experiments on Binary Refrigeration," Mr. Edgar Penney; "Multiple Effect Compressors," Mr. G. T. Voorhees; "The Water Jacketing of Ammonia Compressors," Mr. R. L. Shipman; "Engineers' Specifications vs. Contractors' Warranty," Mr. John C. Wait; "Data on Water Cooling Towers," Mr. B. Franklin Hall, Jr.; "Oily Waters and Their Treatments," Mr. Albert A. Cary. Some of the subjects that will be discussed topically are as follows: "What Precautions are Necessary to Safely Test an Old Compression System with Air" "Experience with Different Forms of Piston Rod Packings," and "Concrete Construction for Ice Tanks."